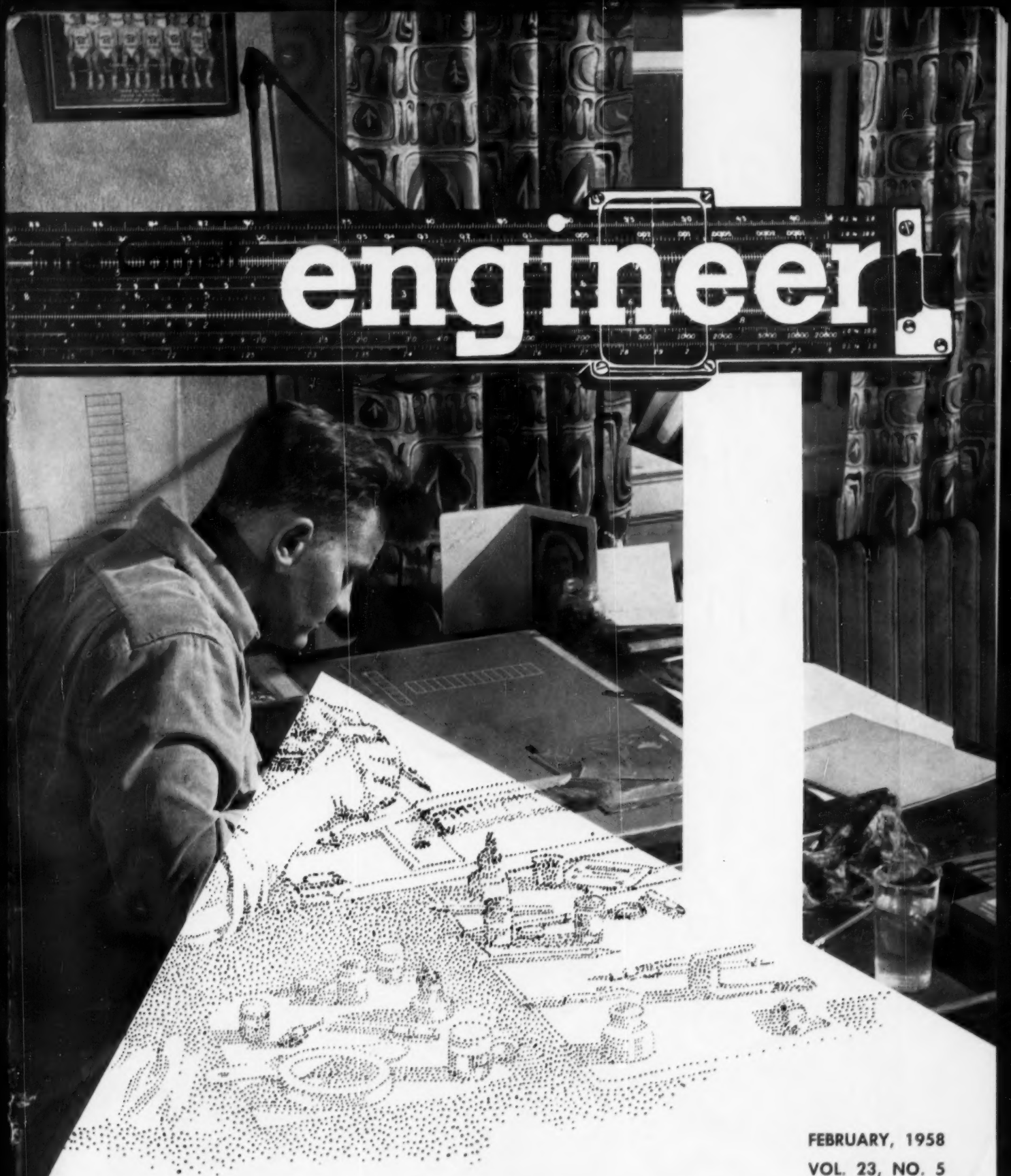

engineer

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VOL. 23, NO. 5
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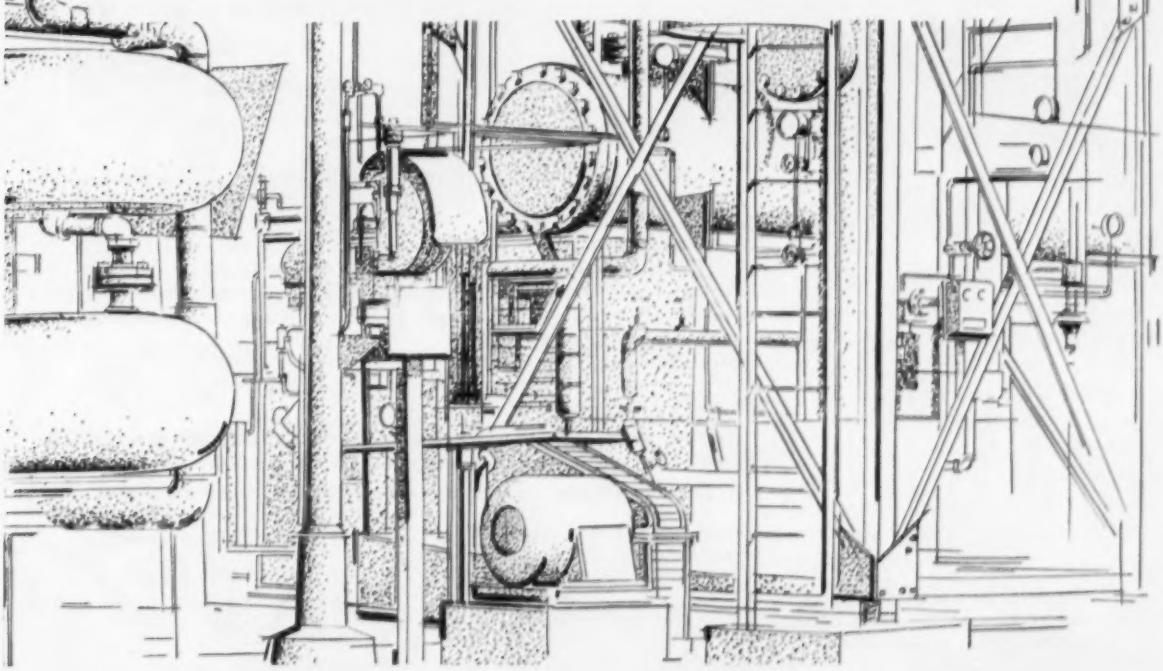

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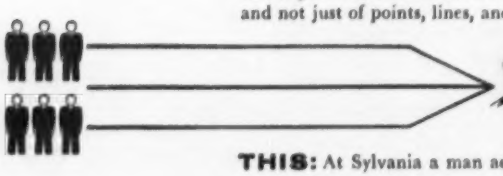

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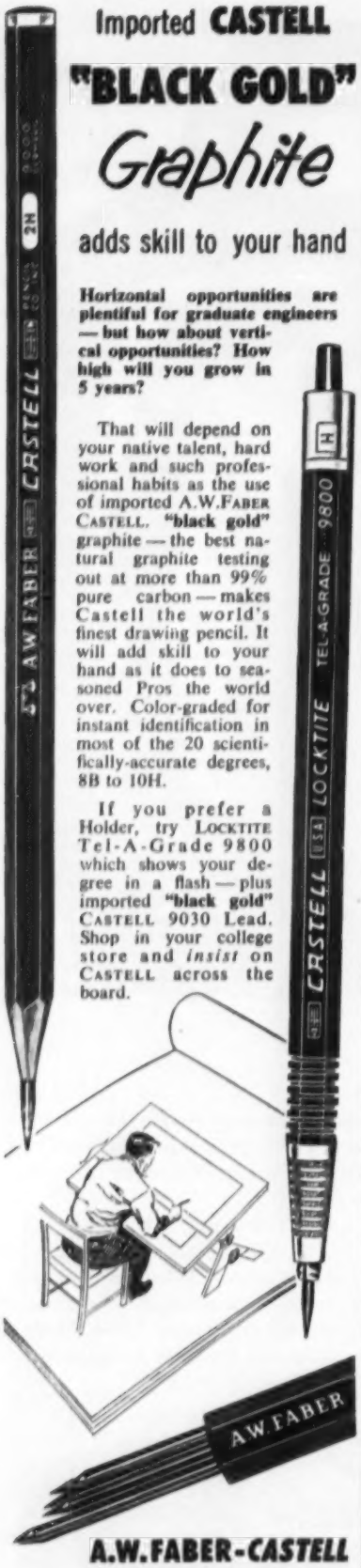

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Harvey Graves (Dartmouth, BA '50, MSEE '51) discusses a reactor experiment at the Westinghouse Reactor Evaluation Center, in Waltz Mill, Pa. As manager of the Nuclear Design Section, Mr. Graves works with Dr. Wilfried Bergmann (Vienna, PhD '51), on right, and other young scientists who operate the facility.

At 30, Harvey Graves directs nuclear design of two major Westinghouse reactors

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In 1955, he was promoted to supervisory engineer on the Belgian reactor project. In 1956, he was again promoted to Manager, Westinghouse Nuclear Design Section. Today, Mr. Graves' 24-man section is developing and designing the nuclear portion of commercial reactors for the Yankee Atomic Electric Company and the Center d'Etude de l'Energie Nucléaire in Belgium.

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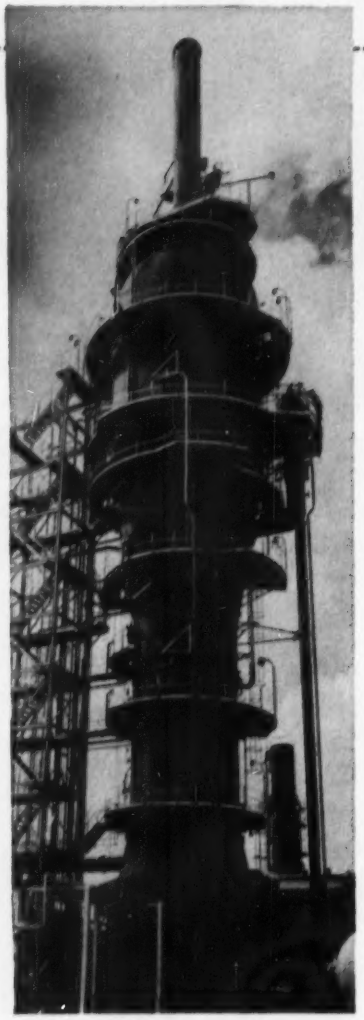

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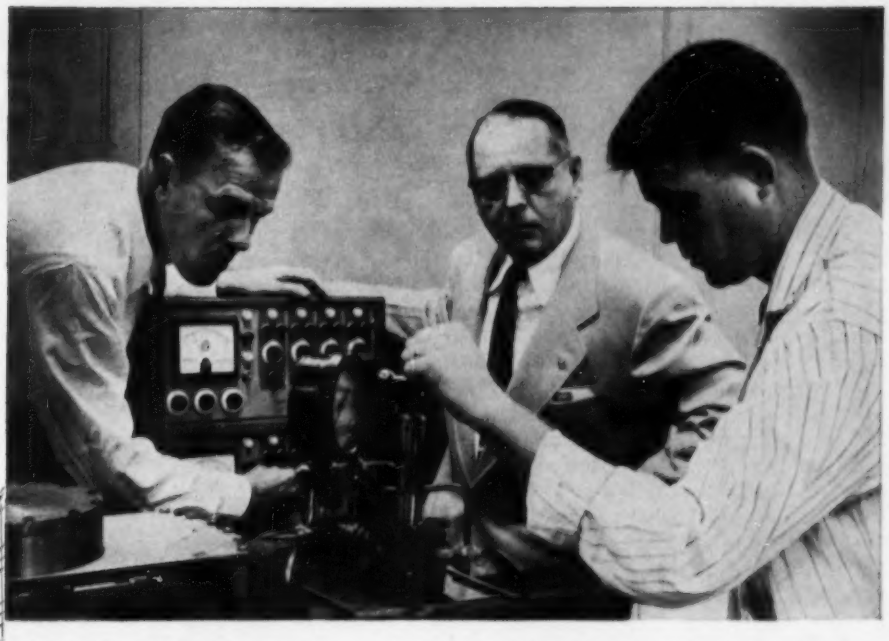

BREAKING BARRIERS in friction research, GM engineer-in-training Donald Hamilton (r.) works closely with Robert Hellmann, M.E. '41, and O. K. Kelley (c.). One of the nation's leading automatic transmission authorities, Mr. Kelley holds 24 patents, directed Transmission Development Section of GM's Engineering Staff before his recent promotion to Chief Engineer of GM's Buick Motor Division.

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Editorial:

WHAT ENGINEERING EDUCATION IS NOT

The more than 1500 prospective engineering freshmen reading this issue are in process of making one of the most important choices of their lives—the choice of an engineering education. Yet many potential engineers lack information to make an intelligent decision in the light of growing national demands for more and better technically trained leaders. High school students must know what engineering education is not, and then evaluate their own ability and dedication before they enroll in an engineering school.

Colleges of engineering cannot afford to provide instruction for vocational schizophrenics who consider engineering studies a necessary evil for their future business success and an "interference with their education." In like manner, there is no place for the young person whose parents rationalize "is smart but just doesn't work hard."

The cost of technical training, the demands on faculty and administration, the responsibility to stimulate the good student and the dilemma of time limitations in the engineering curriculum should be considered by every prospective freshman engineer. If one's ambition and ability do not measure up, then admission to a college of engineering not only disrupts an individual education, but prevents the college itself from being fully effective in meeting the pressing demands it faces for educating good engineers.

High school seniors must understand that engineering at Cornell is not a cafeteria education enabling the student to personally select a group of courses that sound interesting to him. The primary requirement of any person with a Cornell engineering degree is professional competence. Engineers must, therefore, engage in a rigorous program of study involving a variety of technical disciplines. It is the rare individual who finds all required technical courses interesting or enjoyable. Professional necessity dictates that the administration of the College of Engineering and the faculties of the engineering schools present a curriculum that, to the best of their abilities, is adequate to the demand for engineering leadership in a nuclear age. The resulting course of study requires self discipline and perseverance on the part of the student.

Engineering at Cornell is not five years of drama and inspiration. Technical subject matter, unlike literature, philosophy, history, or art, is rarely "inspirational" in itself and can seldom be taught as such without becoming absurd. However, technical courses are not inherently dull. Inspiration and meaning must be sought by the student himself, by using his own initiative to relate and organize the facts of nature as creative tools for service and search.

Students who expect teachers and texts to unlock the wonders of nature with awesome eloquence should recognize the satisfaction of verifying theory by collecting their own data in a laboratory experiment, and combining mathematical analysis with ingenuity in designing simple, inexpensive solutions to difficult problems. The student of the liberal arts usually does not write a novel, create a philosophy, paint a picture, or discover a lost culture when he graduates. But the graduate engineer must *do* engineering. He cannot be a spectator. He must be a builder. His education challenges him to build just as he must build when he goes to work.

Cornell engineering education is not intended for persons who cannot work with others effectively. Persons with really outstanding inventive genius who prefer working alone might better consider a career in pure science. The engineering profession is one of communication. Drawings, calculations, and graphs are obvious means of expressing technical concepts. More important is the ability to communicate in speech and writing, to share ideas with engineers and non-engineers who are affected by technical decisions. The engineer must be able to listen carefully and discuss intelligently in order to understand a problem. He must then be able to coordinate and comprehend ideas and skills of others to work out a solution. Finally he must present, explain, and convince in order that his solution be accepted and used. Students who want to avoid patient listening, clear speaking, and correct writing, and who resent team thinking should not choose engineering.

Finally engineering education is not a guarantee of technical and vocational adequacy. When the class of 1963 graduates, graduate work to complement even a five year engineering course will be a major alternative for seniors. The trend in engineering education will be to more mathematics and science to enable better understanding of new materials and environments demanding engineering analysis. The undergraduate years alone are rapidly becoming inadequate for the challenge and import of technology. High school students considering engineering may desire to follow through with graduate study. They must understand that engineering education is not an end. It is a beginning for the program of continuous self education that is a life-time project for a good engineer.

High school students who want to be engineers must discipline themselves to study technical subjects that have varying personal interest and use their own initiative to find meaning in their college work. They must cultivate their abilities as communicators, and be willing to continue their education for a lifetime. With these factors in mind high school seniors can look forward to their years at Cornell as rewarding preparation for their chosen careers, because they will have a better understanding of what engineering education is not.

—R.G.B.

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by
H. J. Hollberg
Du Pont
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As you might guess, Du Pont's personalized training is closely related to its promotion policy. Almost all advancement is made from within the Company, so if your supervision has indicated that you are ready for promotion, and an opening occurs for which your training has prepared you, you are sure to be considered.

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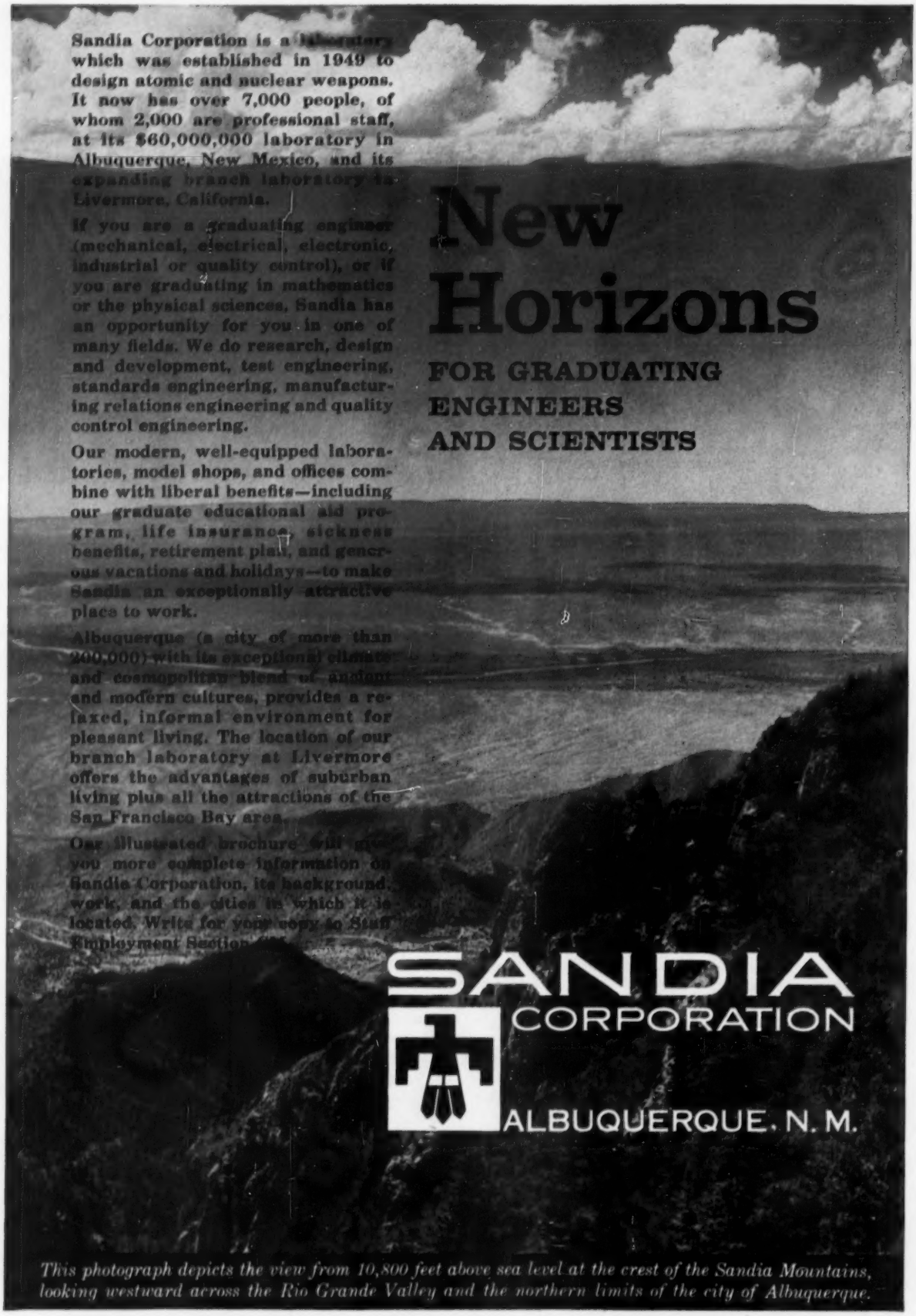
* * *

Du Pont, over the past 25 years, has spent $1 on research for every $3 on production facilities.


Sandia Corporation is a laboratory which was established in 1949 to design atomic and nuclear weapons. It now has over 7,000 people, of whom 2,000 are professional staff, at its $60,000,000 laboratory in Albuquerque, New Mexico, and its expanding branch laboratory in Livermore, California.
If you are a graduating engineer (mechanical, electrical, electronic, industrial or quality control), or if you are graduating in mathematics or the physical sciences, Sandia has an opportunity for you in one of many fields. We do research, design and development, test engineering, standards engineering, manufacturing relations engineering and quality control engineering.
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This photograph depicts the view from 10,800 feet above sea level at the crest of the Sandia Mountains, looking westward across the Rio Grande Valley and the northern limits of the city of Albuquerque.

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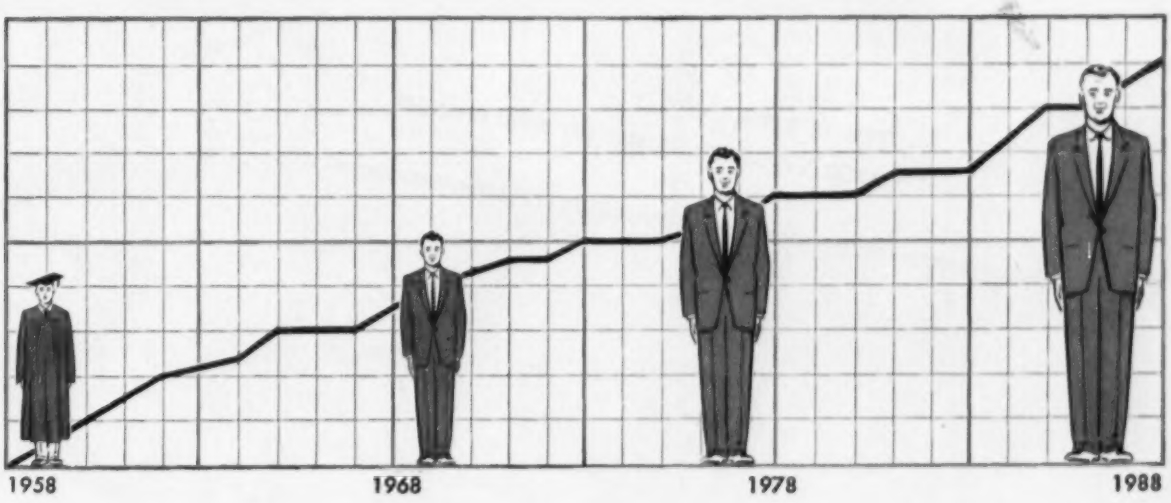

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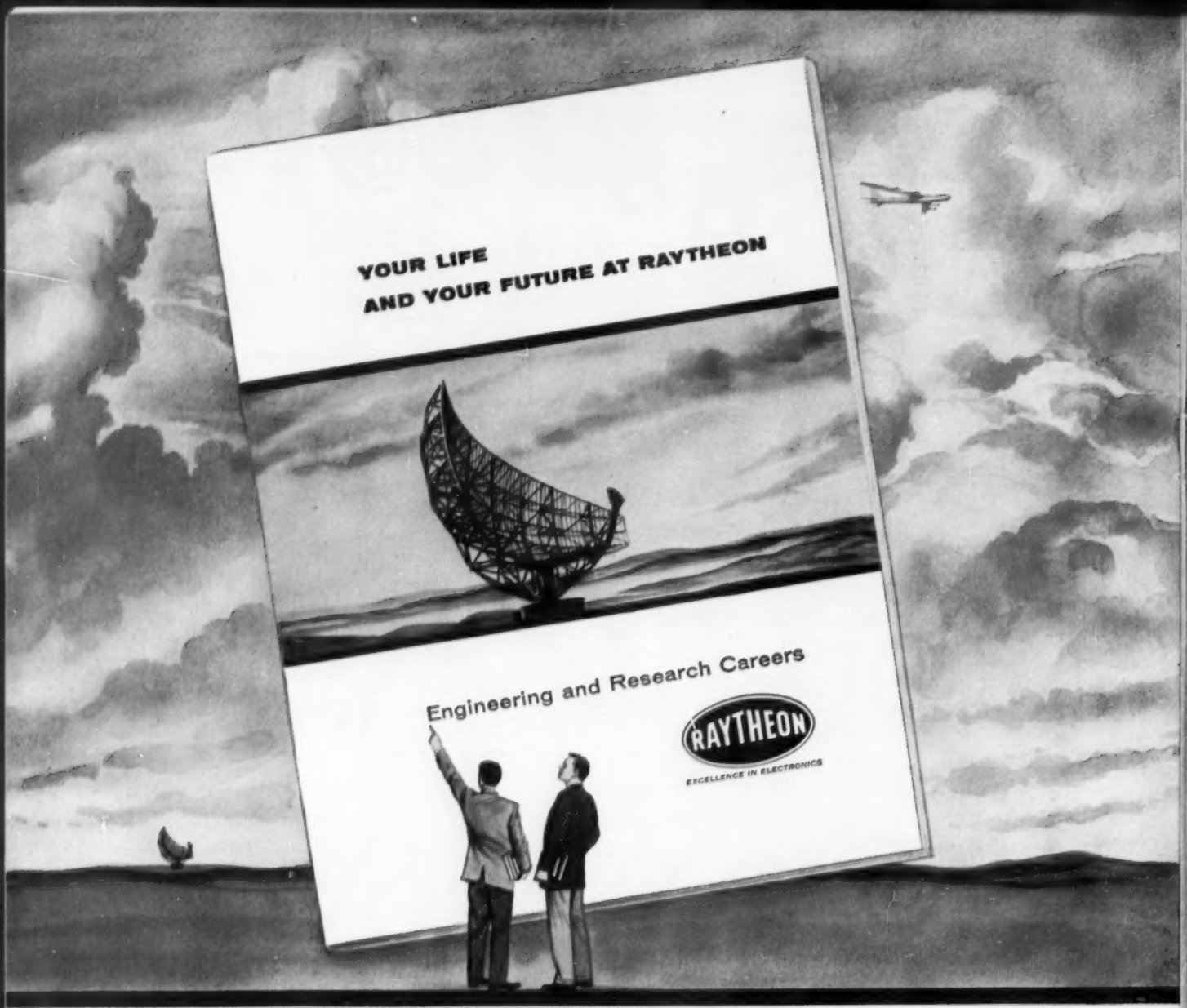

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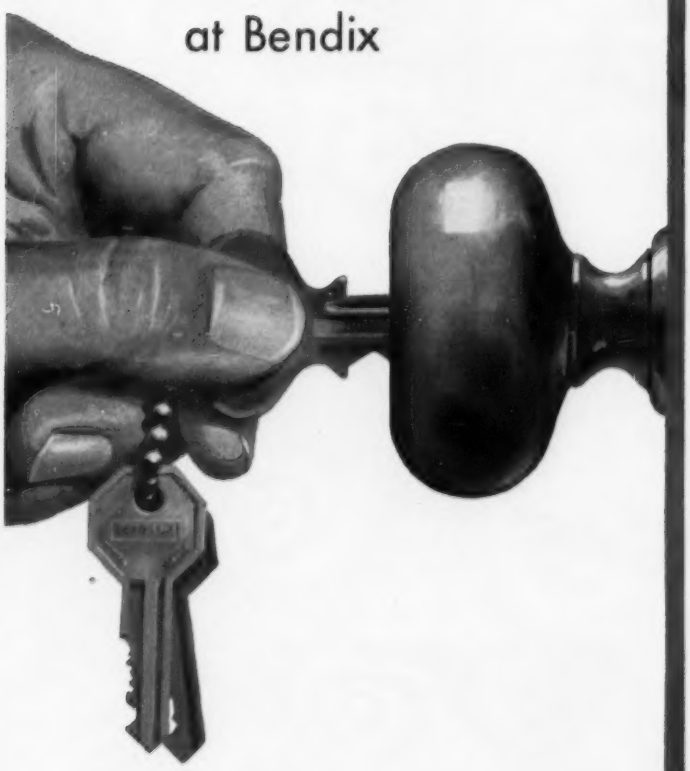

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PHYSICS AND THAT FIRST YEAR

by

Prof. G. E. Grantham

Interest of recent months in intercontinental missiles and man-made satellites has brought about a study of the growing lack of interest of high school students in the subjects of physics and mathematics. This study reveals that at the present time about 76 per cent of American high school students do not choose physics as their science in high school, while in Russia the graduates of their schools, which are the equivalent of our high schools, have had five years of physics. The advances in missiles, satellites, and ballistics made by the Russians in recent months have been attributed to the emphasis they have placed on science and mathematics in their entire school system.

Of the students who start an engineering curriculum in America, at the present time, far too many become discouraged and drop out of engineering in the first year due to failures in physics and mathematics. There are many reasons for these subjects being stumbling blocks for the students, and that physics is a growing science, and hence more difficult, is not a valid reason.

The writer first taught physics to engineering students at Purdue University in 1909. He has been engaged in this interesting work, with the exception of two years in military service in 1917-1919. This work has been carried on at Purdue University, at Texas A and M College, at the U.S. Naval Academy, and at Cornell where he has seen students facing the same difficulties and discouragements in their study of physics. After all these interesting years, one should be able to offer advice to incoming students of engineering, which if followed, would help to minimize the high mortality resulting from discouragement and failure in the first years of their study of engineering. The object of this article is to point out some of the causes of these failures and to suggest remedies.

Understanding the Principles

Physics is the fundamental science of the natural world. It is an experimental science, and the laws and formulae given in text books of physics are merely statements and shorthand descriptions of what happens in nature under certain specified conditions. An understanding of these basic facts enables the engineer to predict what will happen under given conditions without building the equipment to test the reliability of new devices. In fact, knowing these laws enables the engineer to design the machine to perform the task desired without "cutting and trying."

To give an example of a basic law which has many important applications in engineering and in our everyday experiences, the so called Second Law of Newton is offered. Sir Isaac Newton (1642-1727) stated several laws which are basic to engineering. These laws were stated after observing the results of experiments. This Second Law may be stated as follows: "When an unbalanced force, F, acts on a body, there is produced in that body's motion an acceleration, a, which is directly proportional to the force,

ABOUT THE AUTHOR

Professor Emeritus Guy E. Grantham recently completed an active forty-four year teaching career. During this time he taught freshman physics 115-116, then popularly known as "Grantham's Circus." Another of his noteworthy contributions was the planning of the Engineering Physics curriculum at Cornell. In 1950 he was appointed as executive officer of the physics department.

No longer teaching the freshman physics course, Professor Grantham still devotes a good deal of his time to University activities. He presently is coordinating the freshman tutoring program instituted in September.

Among the professional and honorary societies to which he belongs are Phi Beta Kappa, the Optical Society of America, the American Physical Society, the American Association of Physics Teachers, and the American Association for the Advancement of Science. His complete "Faculty Profile" appeared in the November, 1954 edition of THE CORNELL ENGINEER.

Norman Brockmeier

Prof. Guy E. Grantham

←

Frontice—Professor Guy E. Grantham explains physical phenomena easily to large groups, making physics lecture a day's highlight.

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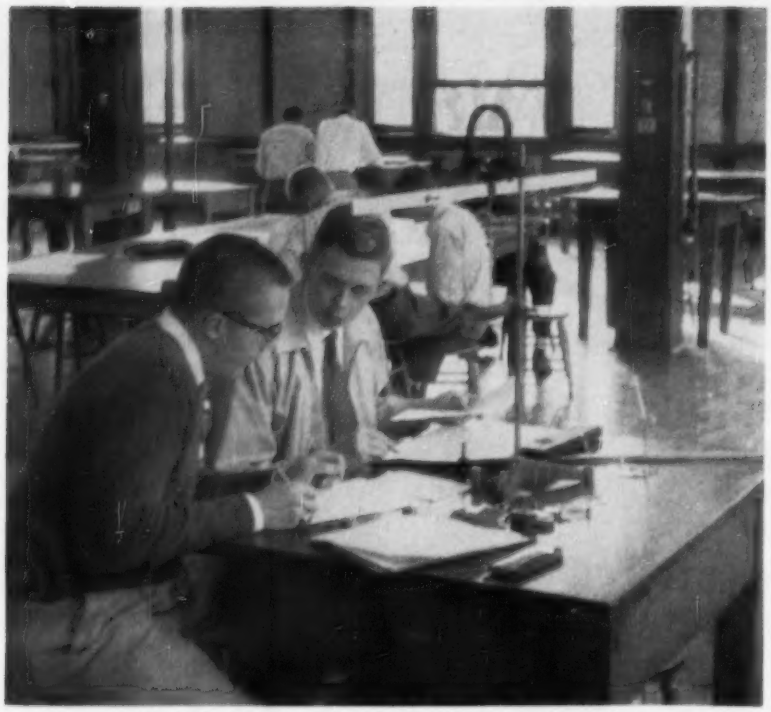


Verifying elementary physical laws in Physics 115 Lab.

in the same direction as the force, and which is inversely proportional to the mass, m, of the body." Expressed in mathematical shorthand the law is $ka = \frac{F}{m}$ where k is a constant of proportionality, the value of which depends upon the units used for measuring force, mass, and acceleration. It is common to choose a unit for either m or F which will make k equal to unity and then the expression for the Second Law becomes $F = ma$. Such shorthand expressions become known as formulae.

Memorization of this formula, without an understanding of the basic experiments back of it can only cause confusion to the student who attempts to use it. He must recognize that F is the net or unbalanced force acting on the body and not just one of several forces which may be acting on the body. A book at rest on a table has the attractive force of the earth acting on it, and the table pushing upward on it, but neither of these forces produces an acceleration because neither is an unbalanced force acting on the book. Either of these forces acting alone on the book would produce an acceleration. Should the table suddenly collapse, the attractive force of the earth acting on the book would produce an acceleration.

It is not difficult to set up demonstration experiments to show the validity of Newton's Second Law over ranges of values commonly used in engineering. In such cases it is assumed that the mass of the body remains constant throughout the experiment. Other experiments have shown that if the velocity of the mass approaches the value of the velocity of light, the mass increases and the variation of mass with velocity must be determined. This has been done and, when a particle has a very high velocity, this variation must be taken into account.

More Than Simple Substitution

This Second Law of Newton seems to be a simple law, and its shorthand form, $F = ma$, is short, but each year in college physics examinations, that examination which covers the applications of this law is the one on which students of engineering make the lowest grades of the term. Too often the student feels that when he has memorized by rote the law and a formula representing it he has accomplished all that is necessary, but, if he does not keep to the forefront the experimental facts which the expression represents, he is very apt to fail to make the correct application.

The problems of physics, so dreaded by many students, afford him the opportunity to apply the laws of physics. It is a common mistake of many students who study physics to start with the idea that the solution of problems is just a matter of finding the right formulae in which to substitute values given in the problem and that the correct answer will result. A careful analysis of what is involved is necessary before one attempts to use the formula and the "formula memorizer" is soon in difficulty.

In the experience of the writer, one class of engineering students had so many formulae memorizers in it, that to discourage this habit, some weeks before the final examination in the course 5" x 8" cards were passed out to all class members. There were over 500 students in the class. On one side of these cards was stamped "Do not write on this side." The students were told that they could write on the other side of the card any information they wished and that they could then use this information and card on the final examination. The only condition specified was that they would turn in this card with their examination booklet at the end of the examination. The physics staff agreed to make no use of these cards until all grades of the course had been reported.

These cards made out at Cornell in 1940 are still in the possession of the writer, and they afford an interesting study. Some of the cards have so much material finely written on them that the owners used small magnifying glasses in order to read them. In the main the card was covered with formulae, definitions and statements of laws with the formulae leading in the amount of space covered. The extremes were the cards written so finely that magnifying glasses were needed to read them and the card which one student submitted on which he had only a single "$F = ma$" in letters of a size limited only by the dimensions of the card. There also was the card on which the student had written "$F = ma$"

in letters of a normal size as many times as the space permitted.

The results of this examination were shown by the lowest marks we had had on a final examination over a long period of years. Apparently some students felt that when the card had been prepared there was no further need for study. The experiment proved to some that success is not accomplished in the study of physics until one understands the basic experiments which are behind formulae and laws.

Course Organization

In colleges in which the number of students in the basic physics course is of the order of four or five hundred students, it is common to divide the work into sections or small groups of students who work together under the supervision of an instructor. In this way more personal contact can be had than when large groups are formed. A grouping used in many schools is (a) the demonstration lecture, (b) the recitation section, and (c) the laboratory section. The following is a brief discussion of the advantages of this grouping in the order stated. Each student of the course belongs to all three groupings.

(a) The demonstration lecture may have 250 or more students handled by one lecturer. Experiments using expensive equipment such as apparatus to show the famous Cavendish Experiment or to show the Brownian Motion to the whole class at the same time can be used and require only a single setup for each such experiment. Such experiments can be shown and the experimental procedure outlined before large groups; consequently, in the interest of conservation of both man-power and expensive equipment, it is customary to give from one to three such lectures each week. The experienced lecturer can point out the basic principles involved and help the student in the method of analysis of problems. When a large number of students are in one group, questions from the floor cannot be permitted and these questions must be reserved for the recitation or laboratory sections or perhaps presented at the end of the lecture. Such lectures, in addition to expensive equipment, require experienced lecturers and specially equipped lecture rooms. The close attention of the student to the demonstrations will pay off when the student reads the subject matter in the text or when he performs experiments for himself in the laboratory. Using the lecture hour as an hour to sleep is not recommended.

(b) The recitation section is usually limited to groups of twenty or less students who meet in classrooms equipped with blackboards. This section commonly meets two or three times each week. Here are discussed the previously assigned textbook material, the experiments of the demonstration lectures, the laboratory experiments and the solution of problems illustrating the applications of physical laws. In these smaller groups, the individual student has an opportunity to ask questions and to gain practice in the solution of problems. The recitation section is actually the "clearing house" for the work of the

Richard Epstein

course. Here quizzes of ten to twenty minutes length are given periodically to give the student practice in writing out the answers to questions and in solving problems which help the instructor to evaluate the progress of his students. During the term two or three one-hour examinations ("Prelims" at Cornell) are given to the whole class so the work of one recitation section may be compared with that of other sections. Of the three parts of the work being discussed the recitation section affords the best opportunity for the instructor to weigh the work of the individual student.

(c) The laboratory work is usually carried out in a 2½ to 3 hour laboratory period, once each week, in which not more than two students work together with a single experimental setup. Fundamental experiments are selected covering the subject matter of the term and usually twelve to fifteen separate experiments are performed. Here the student acquires manipulative skill, methods of analyzing and tabulating data, ideas relative to the accuracy of measurements and a knowledge of how to compose a scientific report.

Each of the three divisions of the work just discussed helps to clear up and make more meaningful the work of the others, and no one of them can be neglected without an effect on the understanding of the others.

In determining the grade at the end of the term each of the three divisions is stressed in the final examination and each has its weight

Jeffrey Frey

Professor Newhall keeps students in suspense while testing the principle of conservation of energy.

in determining the final mark in the course. The work of the recitation section is perhaps given the greatest weight, for it is here that the instructor has his best chance to observe the accomplishments of the individual student. The final mark in the course is made up of the recitation mark, the "Prelim" mark, the laboratory mark, and the final examination mark.

Interest Is Important

If after years of experience with first year engineering students, the writer was asked to list the factors which are least conducive to good work in physics, he would list, first, lack of interest in the subject. Too many students choose science or engineering because they have been told these lines would guarantee fi-

(Continued on Page 59)

ATOMS FOR THE FUTURE

Edited by **Alan S. Rosenthal EE '60** from an address entitled "Our Atomic Future" made by **J. Carlton Ward, Jr., B.M.E. '14** before the 12th annual flight propulsion meeting of the Institute of Aeronautical Sciences.

Cosmologists and Anthropologists believe that man has been on this planet for a little over a million years. During this first million years almost all of his work was done by muscular energy. Few natural forces were utilized until 1700 when a very simple steam engine was built for pumping water out of a deep mine shaft in Wales. But this event marked the start of the Industrial Revolution.

While the Industrial Revolution was in progress in England, the United States was content to use the readily available water power of New England. However, more and more mechanization followed, resulting in mass production and "automation."

Energy and Living Standards

The United States' need for energy grew tremendously and finally reached a point where it outstripped that of all other nations. As this need was met, the nation's standard of living improved.

Civilization is simply a product of energy put to use. The living standard index is the sum total of all goods produced plus all the services that are produced, divided by population, using a constant value for money. But nothing can be produced today without energy; therefore, the energy available in any given country divided by its population is a measure of its standard of living, of its economic strength, and of its economic potential for national defense.

Understandably, population increases demand greater power production. The United States Census Bureau estimates a population increase for the U.S. of 3 per cent per year. Power demands, however, are expected to increase at a rate of 7 or 8 per cent each year. Such demands will require the nation to double its power output every decade.

Thus, tremendous amounts of power are needed to maintain the desired standard of living. Another factor affecting power requirements is the natural law stating that the energy needed to move a body increases with the cube of the speed. As man tries to travel faster and faster, power requirements increase enormously.

Turning to Atomic Energy

In no economy is the demand for energy as insatiable as in the United States. Materials are available to meet these requirements. For instance, scientists have developed substances that will give up 50 per cent more energy per pound in chemical reactions than traditional petroleum fuels. Unfortunately it is not possible to compound energy output from chemical reactions forever. Chemical energy is derived from electron forces in the atom structure, and these are limited by nature.

In order to overcome this limitation, Britain has announced a program of building 15 million kilowatts of electrical capacity from atomic energy in the next five to ten years. That program worried many people in the United States who feel that the British have moved ahead in the development of atomic energy by providing atomic power plants more quickly than this country. However, it must be remembered that the British do not have the sources of raw material for fuel that the U.S. has. They cannot produce the coal that they need to run their economy, and they do not have the dollars to pay for the coal from the United States. Thus they are going into atomic energy in the quickest, easiest way because they have to. This country, on the other hand, is trying the engineering-scientific approach toward gen-

J. Carlton Ward, Jr.

J. Carlton Ward, Jr., president of the Vitro Corporation of America and member of the University Board of Trustees, is one of the most well known, active members of the aircraft industry. Among the many organizations he has worked with are the Aircraft Manufacturers' Council, the Aircraft Industries Association, the Bureau of Aeronautics, and the Nuclear Energy Propulsion project of the U.S. Air Force and Navy Bureau of Aeronautics.

Mr. Ward entered Sibley College in 1910 and received the M.E. in 1914. He is a member of Tau Beta Pi.

A former member of the University board of trustees, Mr. Ward has served Cornell as a member of the Engineering College Council. He has also played a vital role in assisting the University development of sponsored research.

erating atomic energy by a wide variety of kinds of atomic plants and atomic fuel combinations. These early forms of atomic plants do not yet compete favorably with cheaper fossil fuels in combination with modern highly developed steam-electric and hydro-electric plants.

The Research Problem

The development of atomic power plants is a direct product of laboratory research. The first industrial research program was not organized until 1903. Indeed, the amount of research done in this country before World War I was practically nil. The First World War brought a tremendous upsurge in research. Although research work was continued by industries after World War I, it was not until the Second World War that research again was helped by the government.

With the close of World War II government again abandoned research. Industries, however, realizing its value, continued to do a good deal of scientific exploration. The aircraft industry helped show the government the need for basic research by investigating the possibility of atomic planes. In consideration of the cubic relationship between energy and speed, it became apparent to the leaders of the industry that atom powered bombers would eventually be the best means of meeting defense requirements.

With the coming of the Korean conflict, government supported research again increased, but, disregarding the advice of industrial leaders, Congress reduced research expenditures after the war. Throughout the past years it has always been private industry that carried on research during periods of governmental indecision. With the present "crash" program on scientific development underway, the government again seems to be "carrying the ball."

While applied atomic research is of extreme importance, basic research is not to be neglected. Vannevar Bush said in his famous book, *Modern Arms and Free Men*, that the nation used up fifty years of fundamental research in the five years of World War II and that it was one of the most serious things that could happen if allowed to continue uncorrected. Something is being done. The universities, for instance, have taken a role in American affairs which they never have had traditionally. Of the dollars spent in the United States for research before the war, only a small amount was spent in universities. Today it is nearer 10 per cent and of a larger figure. Here is where the bulk of the basic research is done. Applied research would be meaningless if it did not have new basic research on which to feed.

The United States, which formerly depended heavily upon Europe's basic research, has finally become sophisticated. Its basic research has begun to increase in step with its applied research and development. This awakening is one of the most healthful developments that could have happened to the American economy.

The biggest single research effort that the taxpayer feels is in atomic energy. More than seven billion dollars has been invested in the atomic plant facilities owned and operated by the United States. The annual operating cost is over two billion dollars. A large share of it goes into research. It is in this area that modern metallurgy is being remade; it is here that the atomic energy of the future is being planned.

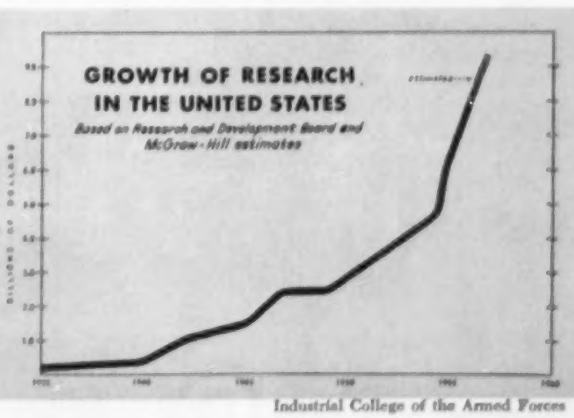
Everchanging Power Sources

The trend towards the use of atomic energy is not a sudden reversal of scientific thinking. It is the result of much scientific research. Fuels have always been undergoing changes. New energy sources have constantly been developing while old sources have been abandoned.

One hundred years ago the United States' chief power source was the draft animal. In 1850, the burning of wood and the personal efforts of man were extremely important. Today they play a relatively insignificant part in the nation's economy. Coal, oil, and natural gas prove to be the major sources of energy. It is interesting to note that water power has continued to provide approximately the same percentage of total power produced throughout the past 100 years.

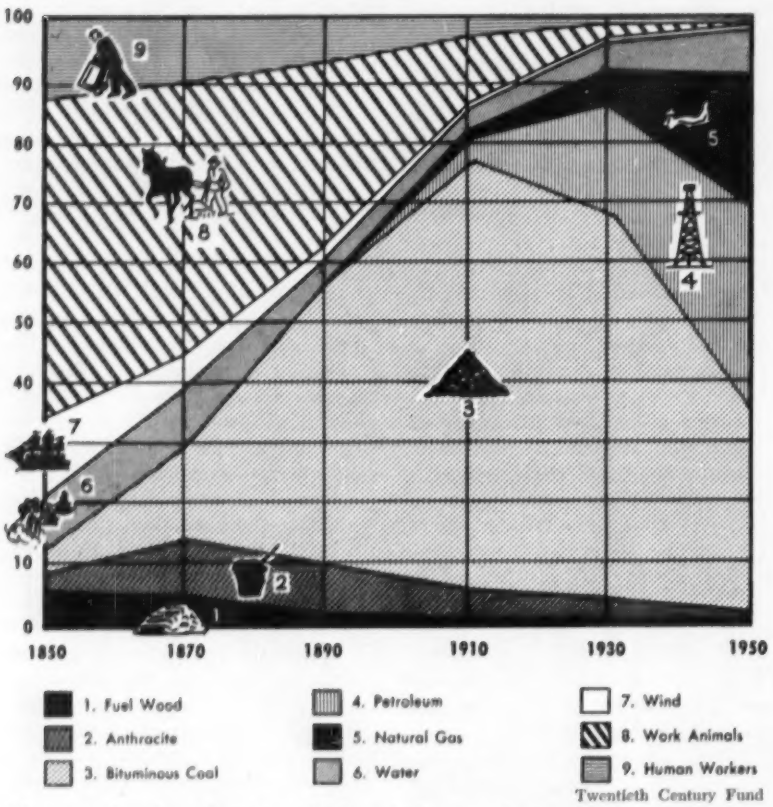
Oil and gas are relatively new energy sources to this economy, yet, in a comparatively short time, they have taken places of extreme importance. Few people realize, however, the great value of oil, for instance, as a basic source of carbon compounds which are essential to civilization in a material and chemi-

The close relationship between living standard and power production is clearly demonstrated by this graph.



Industrial College of the Armed Forces

Research increased tremendously in the past twenty years when, with the advent of World War II, people began to understand its economic value.



Oil, gas, and coal are shown completely replacing muscular power as a per cent of the total energy produced in the United States.

cal sense rather than as a source of energy by combustion. It is conceivable that in the long range it will be impossible to burn oil indefinitely; it is becoming too valuable as a source of chemical raw material.

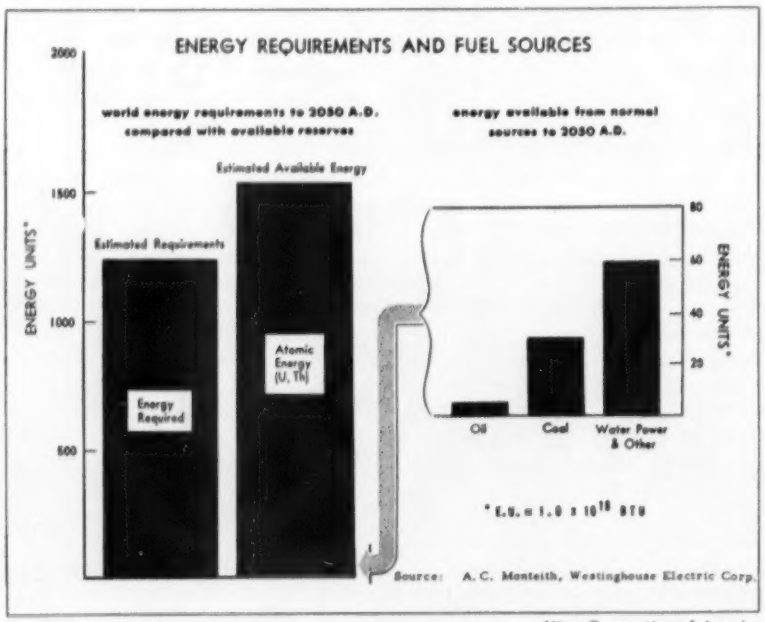
One can see why the use of oil as a fuel may sometime in the future have to be outlawed to prevent the exhaustion of the chief source of basic industrial organic chemicals. And much the same thing could be said of coal and gas. Comparatively new methods of coal hydrogenation have made that fuel another very valuable source of raw materials. Here much research and development remain to be done, as in the case of extensive deposits of tar sands and oil shales.

With fossil fuels available only through the goodness of nature and with a growing demand for them in the synthetic industries, it becomes increasingly apparent that something must be found to replace them as energy sources. Of even more concern is the fact that at present rates of increased power consumption all the coal, oil, and water power available to man fail to meet his energy needs for the next 100 years.

The inadequacy of these resources is so severe that it leaves civilization little choice. Atomic energy must be utilized to the fullest for without it survival at the present level is impossible. By the year 2050 the fossil fuel segment of the industry will have long disappeared.

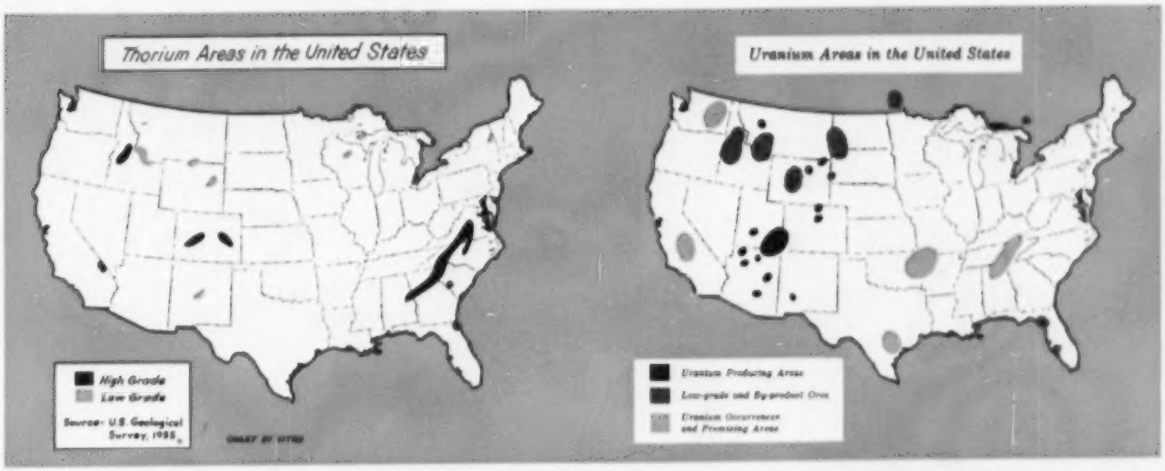
The balance of power needed can be supplied through the use of fissionable material. Of course, a great deal of work needs to be done in order to reduce costs and increase efficiency. With the present sources of fissionable material, it is expected that the nation's energy requirements for the next 100 years can be met. In the next century, the supply of fissionable materials too will probably be exhausted.

The question of what will be done after uranium and thorium supplies are used up is a difficult one. The answer, however, seems to be in thermonuclear power. Particularly in Russia and the United States, it is one of the many reasons for the frantic work that is now being done behind the scenes for the solution of the problem of control of thermonuclear energy release. A



Vitro Corporation of America

Required energy is shown at the left with energy sources shown at the right of it. The majority of the available energy consists of fissionable materials.


Thorium Areas in the United States
High Grade
Low Grade
Source: U.S. Geological Survey, 1955
Uranium Areas in the United States
Uranium Producing Areas
Low-grade and By-product Ores
Uranium Occurrences and Promising Areas

Vitro Corporation of America — U.S. Geological Survey, 1956

These maps indicate the present producing areas in the United States for the nuclear fuels, uranium and thorium.

final solution would solve the problem for a long time to come. And there are still other possible cosmic energy sources. Thus there is no need to accept the idea that in the year 2050 everyone must return to barbarism.

There is, in fact, reason to believe that the world will be able to stretch its estimated supply of fissionable materials. At the close of the fiscal year in July of 1956, the United States was the largest miner of uranium in the world. It was producing three million tons of uranium a year according to the AEC. This figure represents a considerable growth in production.

Since modern civilization is dependent on fuels, it is important to know that today uranium mining is between a 100 and 200 million-dollar per year industry in the United States alone. It has reformed large areas of the West as well as Canada which were practically no-man's land before the demand for uranium came into being. As is often the case in history, a military weapon has provided new techniques on which civilization has made great peaceful gains. Those few people who still may believe that in atomic energy man discovered one of God's creative forces with which man can now destroy himself, must see the picture through a newer and rosier glass.

Most of this uranium today—the three million tons—comes from the Colorado Plateau. Mining has just begun in very rich veins found up in the Spokane Indian areas. There is some in Nevada also, and there's some in California which is not an appreciable factor. Texas has been finding many indications in the San Juan outcrop and also finds uranium associated with certain oil drilling operations but no appreciable production as yet.

The Tennessee Shales also look promising, but these require a new technique not yet practically developed. Then too the great lignite areas of Dakota are associated with large amounts of uranium although there is no presently competitive process for extracting uranium from the lignite.

The Military Factor

Both the NATO group and the Soviet Bloc are consuming more coal and oil than they produce. In case of a major war between these two groups it is to the rest of the world that the United States should have to look for fuel, for the neutral nations hold the key to coal and oil by producing more than they consume. There would be a hard struggle to obtain this excess production, and those who obtain it would very likely hold the top cards in a major world conflict. Here again it is all too evident that unless atomic energy is developed as a military source of fuel, this nation will be in serious danger not necessarily today, but in the future, for even if foreign sources are obtained they might easily be disrupted. Only by means of atomic energy can this country be assured of sufficient domestic fuel for the economy and military needs over a long period. The rapid development of atomic power is definitely in the national interest.

Starting with the very few military projects of the Manhattan Engineer District back in 1942, the number of reactors in the world has grown slowly until the total was slightly more than forty at the time of the Geneva Conference on Atomic Energy in 1955. Since the revelations of that conference, there has been an upsurge in atomic reactor development and the total now projected to be completed by the year 1962, is more than 200. Only a very few of these reactors will be able to generate electric power in the utility or industrial sense, for most of them are research or test reactors. They are all contributing to the knowledge of the art, however, and each one holds an important place in the scheme of atomic development.

Probably the best of the specific examples of the value of atomic energy to this nation's military power is the case of the first atomic submarine, the U.S.S. *Nautilus*. The *Nautilus* went over 60,000 miles or 2½ times around the earth and actually used a calculated 8½ pounds of enriched uranium. This trip would ordinarily take some 57,140 barrels of oil!

The officially proposed new atomic navy is a fantastic concept. Fifteen submarines are already on the way, two operating, and the balance authorized or under construction. Atomic propelled cruisers, atomic power plants for carriers, atomic oilers, atomic merchant ships are all in development stages. This work plus the fact that the

(Continued on Page 68)

ON THE AIR FOR EVERYONE

Peter Gaalaas

by David A. Hodges EE '60

Peter Gaalaas

Resident technical coordinator (alias chief transmitter engineer) Peter Van Raalte, is charged with the preparation of the 250-watt G.E. transmitter for operation.

Sometime this year a new frequency modulation radio transmitter will go into operation on the Cornell campus. WVBR, the Voice of the Big Red, has obtained a license from the Federal Communications Commission to operate a F-M transmitter of 250 watts power on a frequency of 101.9 megacycles. The new transmitter is located in Phillips Hall by permission of the College of Electrical Engineering, and the antenna is on the roof of the building. The entire Ithaca area will be covered from that position.

Cornell students first ventured into the field of broadcasting more than seventeen years ago. In November, 1940 station CRG began operations using small carrier-current transmitters which radiated their standard broadcast frequency signal over the power wires in a building.

WVBR, the present station, is owned and operated by the Cornell Radio Guild, a student organization, and has studios in Willard Straight Hall. Each morning from 7 to 9 A.M. and again in the evening from 4:30 P.M. to 1 A.M. WVBR broadcasts programs of news, weather, music, and special events. Classical, popular, and jazz music are a regular part of the schedule.

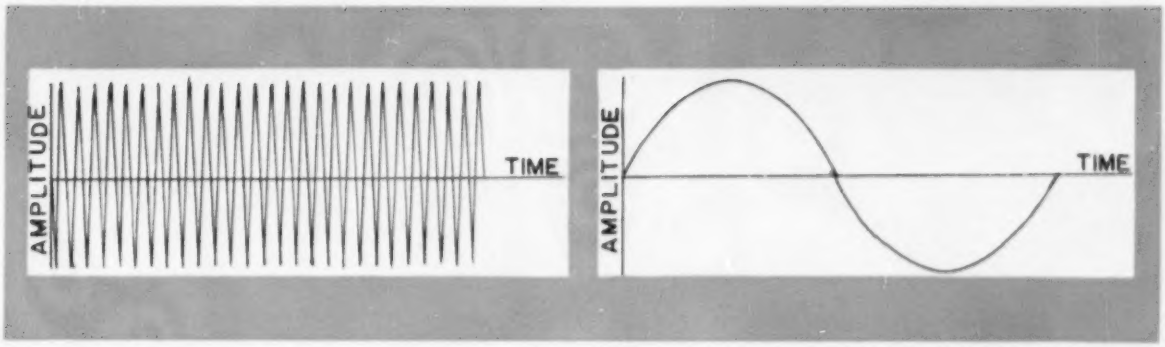


Figure 1—AM or FM carrier.

Figure 2—400 cycle sound.

Robert Franson

Sporting meets and other campus events of particular interest are also included.

Limited Coverage Problem

The staff of WVBR has been seeking a way to overcome their problem of limited coverage of the campus for several years. At present reception can be obtained only in the University dormitories. The arrangement of carrier-current transmitters now in use requires that a separate transmitter be placed in each building where reception is desired. The individual transmitters are then connected to the Willard Straight studios by means of rented telephone lines. The use of these small transmitters instead of one centrally located, more powerful unit is necessary because of the crowded conditions on the standard broadcast band. The Federal Communications Commission will grant no new licenses for the operation of transmitters on the standard broadcast band, for the presence of more stations would worsen the already serious interference problems that exist. The carrier-current transmitters radiate little signal outside the building in which they are installed; hence, they cause no interference and require no license from the F.C.C.

The problems of carrier-current transmission are numerous. The cost of transmitters and telephone lines for each of the scores of student living units on and near the campus would be prohibitive. It is impossible to monitor each of the individual transmitters; therefore, it is also impossible to know immediately when one is not working properly. And even at its best, the sound quality of the signals is limited.

Construction Permit

Faced with these problems, WVBR staff members investigated the possibility of obtaining a license to transmit in the F-M broadcast band. The question of overcrowding, so serious on the A-M band, is not yet significant on F-M. It was discovered that licenses for F-M transmitters were available from the F.C.C., but that the requirements are strict. Regulations concerning transmitter stability and freedom from distortion are such that it is practicable to use only commercially-built equipment. Formerly WVBR staff members had built all the important equipment, but in this case a complete unit had to be purchased. Luckily, a second-hand General Electric F-M transmitter in good condition was located and obtained at a considerable saving.

Another problem faced was that of the F. C. C. requirement for regular broadcasting hours each day. WVBR has always suspended operations during University vacations; F. C. C. operating rules prohibit such irregular procedure under most circumstances. However, after considering WVBR's problems of obtaining listeners, sponsors, and operating staff during vacations, the Commission granted the station permission to continue its present schedule.

WVBR plans to continue the operation of its present carrier-current transmitters. However, listeners with F-M receivers in the Ithaca area will be able to enjoy a new standard of static-free high-fidelity reception when the new transmitter

(Continued on Page 58)

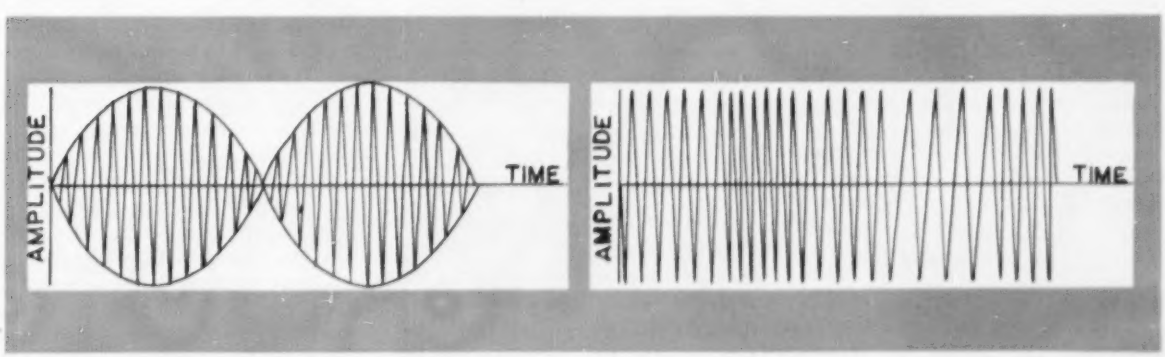
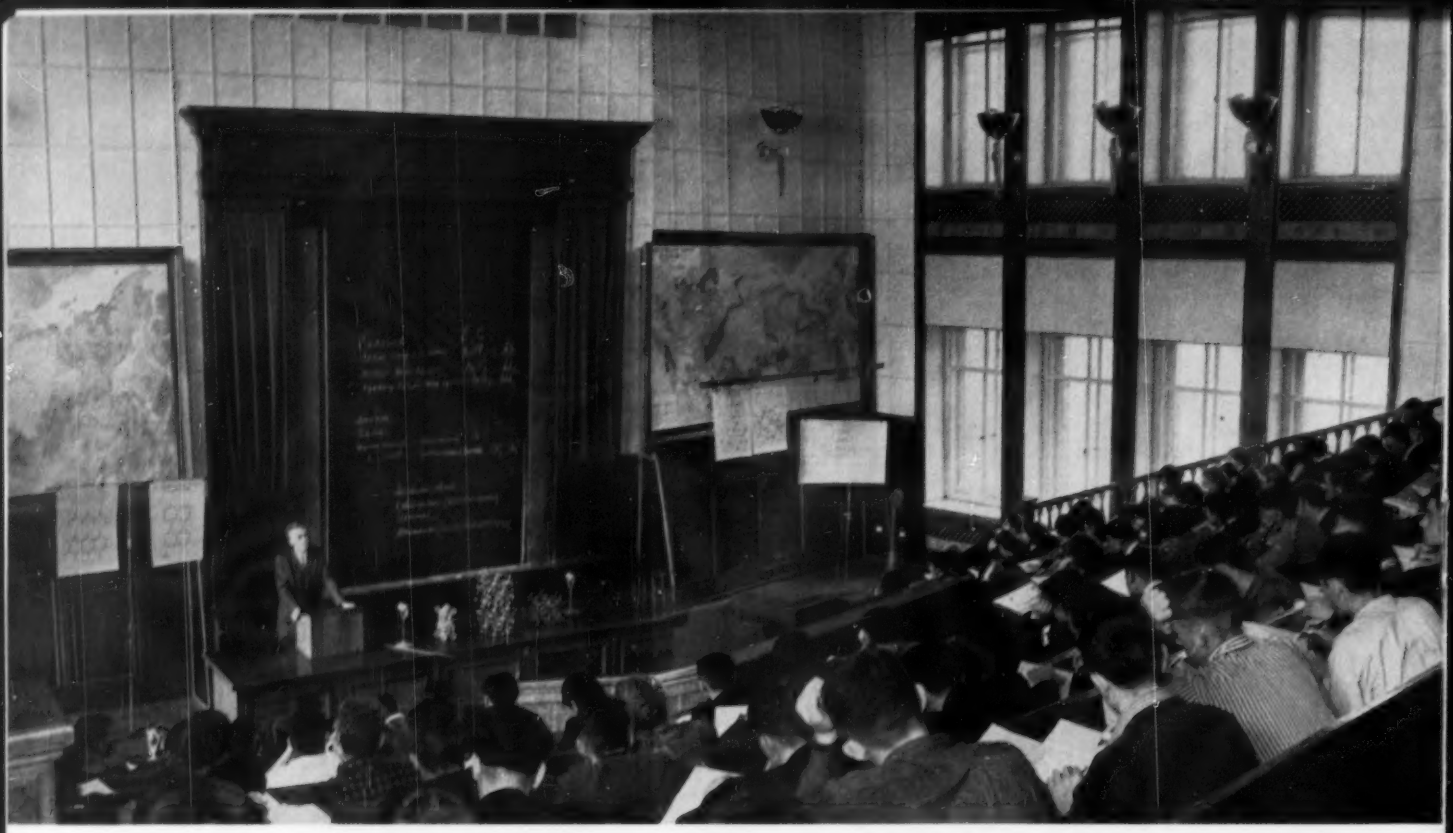


Figure 3—Amplitude modulated carrier.

Figure 4—Frequency modulated carrier.

Robert Franson



THE CHALLENGE OF THE SOVIET UNION: EDUCATION'S RACE WITH DISASTER

by Dr. Glenn A. Olds

Someone has wisely remarked that there are no experts in the Soviet Union, only men with relative degrees of ignorance. Winston Churchill, in his chiselled English, has described Russia as "a mystery wrapped in an enigma, in the midst of a riddle." Still, in the face of space-shrinking Sputniks, telescoping time and accelerating human development, even the amateur must speak. Though judgment may be distortion, silence would be betrayal.

A month in the Soviet Union, however wise or well prepared, is hardly sufficient to make one a prophet. Yet, events since August confirm certain general impressions not widely held or appreciated in this country but now needing earnestly to be laid to heart. As George Bernard Shaw reminded us after the First World War, "Civilization is education's race with disaster." And the memory of Nazi Germany is too recent to permit us to forget that the whole matter turns on the *kind* and quality of education! The scientific success of German education in Nazi Germany, on which both Russia and the United States have admittedly leaned heavily for development of their military missile and rocket race, was no guarantee of civilization's success! Indeed, the way in which even university education, through government directive, encouragement, and subsidy, became the ready hand-

ABOUT THE AUTHOR

Dr. Glenn A. Olds, Director of Cornell United Religious Work, holds degrees from Willamette University, Garrett Theological Seminary, Northwestern University, and Yale University. Before coming to Cornell in 1954, Dr. Olds taught at Yale, DePauw, Northwestern, Garrett, and the University of Denver.

As an ordained Methodist Minister, he preached in churches in Oregon, Connecticut, Illinois, Colorado, and Wyoming. He has spoken at colleges and Universities throughout the United States, as well as at numerous Methodist Annual Conferences.

Dr. Olds is author of the book, "The Christian Corrective to the Campus Confusion," and of numerous articles published in philosophical and religious journals. He is known to Cornellians as a challenging speaker and an effective leader in making Cornell United Religious Work a more meaningful part of the individual student's college life.

maid of a political ideology on the road to disaster is too vivid to permit confidence in the face of the ironic and frantic efforts of an aroused American republic to mimic that memory.

How easy it is to forget Hitler's confident conclusion in *Mein Kampf* that the fatal weakness of democracy was its temptation to copy totalitarian methods to fight totalitarianism. Yet, present political strategy in education suggests a readiness to copy Soviet methods and emphases in education in order to "catch up" in the race toward disaster. What this response reveals is a fatal lack of understanding of the Soviet history, scientific development, and real challenge to the West.

Where Does Russia Stand?

Superficially, of course, the significance of Sputnik was to remind us of several things running counter to the cloudy image Americans have of the Russian citizen, and of the seriousness with which the Russians have taken competition with the West.

(1) The Russians have succeeded in shortening the industrial revolution from 175 to 40 years.

(2) The Russian system of equality of educational opportunity on the basis of intellectual ability has produced significant results.

(3) The prestige of the teacher and the professor in the Soviet system, at the top of the social scale (in a classless society!!) has greatly strengthened ability to attract the best minds into education and theoretical research.

(4) The "science-education" of the masses has given dynamic support to an accelerated scientific advance and adaptation of culture.

(5) The Russians have demonstrated remarkable facility for applied science and engineering, for genuine "know-how", long thought to be a unique and special virtue of Americans.

(6) They have demonstrated remarkable skill in relating scientific and diplomatic skill to the wider world of uncommitted and underdeveloped nations.

(7) They have illustrated that they understand to a degree not yet fully appreciated by Americans the preponderant influence of economic and political propaganda over military offensives, and the decisive strength of initiative in these matters.

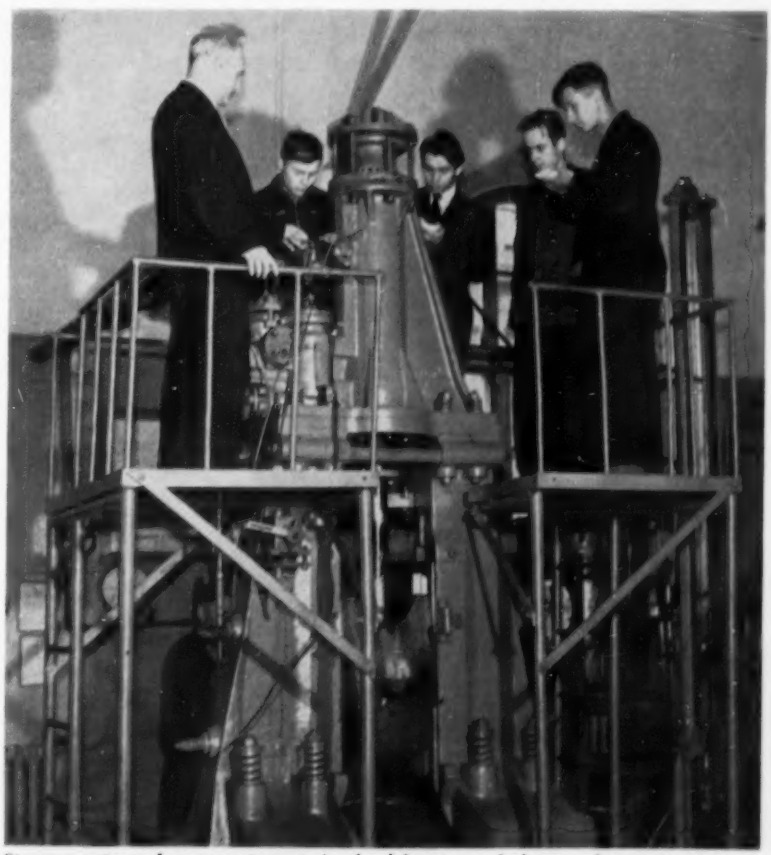
(8) They have demonstrated that if culture is to be measured, as modern man has tended to measure it, in terms of scientific success, we must give up the image of the Russian Bear or the peasant as a clue to Russian character and come to terms with a systematic, sophisticated culture bent on making every phase of its life—religious, marital, and social—fully "scientific".

To appreciate the deeper roots of this obvious development one must see it in the context of a longer history and a deeper dynamic than the scientific. Indeed, one needs to see how the "scientific" is the servant of a history conceived in revolution, and how as method and means it has slowly come to master the mind and life of the Soviet Union.

The Effect of Russia's History

To understand the tremendous motivation for this striking forty-year development, one needs to remember pre-Communist Russia, with its long and tragic history. One has but to recall the incredible peasant poverty in the struggle with a difficult physical environment and an exploitive social system to sense the power and prestige of science as a liberating force against both. In the world's largest country, with one-sixth of the world's total land mass, the peasant struggled against a land isolated through no warm water outlet to the seas, and half of which was frozen six months of the year. The desire to break out of this isolation and encirclement is one of the deepest drives of the Russian. The determination to conquer nature's obstinate resistance to life, to wrest from her her secrets, and to pull the fangs of her alien power is one of the most powerful of the Russian instincts.

A thousand years of semi-slavery under foreign domination of both East and West, culminating in six centuries of the Czarist terror, tyranny, and grudging benevolence,



Stamping steam hammer at work in the laboratory of the metal processing under pressure demonstrated by Professor Anatoli Zimin to a group of third-year students of the mechanical and technological department of the Moscow Higher Technical School

laid bare the impulse to equality of educational opportunity, the motif and method of revolution against the intellectual aristocracy of the few. Memory of the servile status of the illiterate masses under the czars is fresh and moving to the Russian, be he young or old, and he comes to the opportunity for learning with a hunger and social passion almost unparalleled in history.

The crushing load of cultural isolation and loneliness of the Russian people, who have been influenced but never assimilated by either East or West, is a partial clue to the pressures toward a self-conscious national pride and a world-conquering intent of its scientific development. The Russians are proud of their progress, and their new-found place in the "cultural sun" heaps coal on a flaming scientific incentive already related to their own rapid industrial and cultural development.

This progress is conspicuously apparent in education. They proudly point out that at the time of the Revolution 60% of their people were illiterate. Now virtually no one under forty is illiterate. They point to their elementary school systems where foreign languages are taught (English being the most popular) from the fifth grade. We were told by senior American news commentator Henry Shapiro, twenty-three years in Moscow, that his daughter learned in the first six grades in the Soviet public school system what entitled her to promotion to the ninth grade on return to America. He disclosed how longer hours, broader course coverage, and exposure to Communist ideology in clubs, conferences, and common life strengthen the motivation as well as stretch the mind.

An Impressive Education Program

The Russians are proud of their selective promotion system on the basis of intellectual aptitude and performance. From the seventh grade it is possible for students to go into the Teknikum, a four-year "super" vocational and technical school. There are 2,000 such schools enrolling 2½ million students. Other students with aptitude for university work complete secondary training, 8-10 grades, and go on to institutions of higher learning, numbering 789 and enrolling 1,825,000 students.

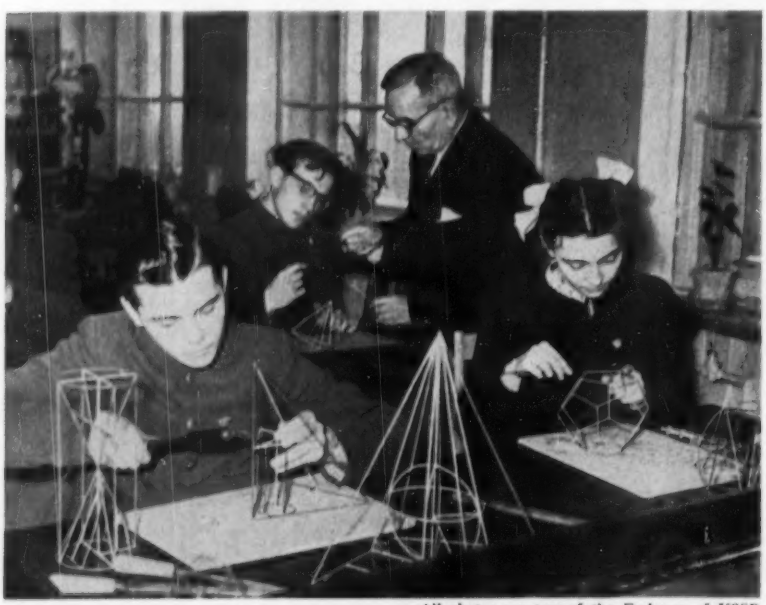
Herein lies the clue to the powerful blend of research and practical application so apparent in the rapid rise of the Soviet Union in these fields. This blend of theory and practice is further fed by opportunity, incentive, and support of the state.

At Moscow University, shining symbol on the cliff overlooking Moscow, of privileged position in the Soviet scale of values, this system is dramatically revealed. Its thirty-two stories bulge with learners sustained by a high degree of motivation, nurtured by a sense of social responsibility, historic destiny, intellectual competence and discipline, and by a system of state incentive and support which gives the student a rare privilege in learning. The University, founded in 1775, and which has graduated 85,000 since its founding and 45,000 since the Revolution, boasts a faculty of 2,000, whose pay scale would make even an American corporation envious.

Members of the Soviet Academy are paid 15,000 rubles a month, or from $45,000 a year. Professors receive 6,000 rubles a month, or from $18,000 a year. And so it goes. The standards and prestige for students are comparably high. Over 8,000 who meet the standards apply, and only 3,000 can be admitted to their student body of 23,500 in twelve faculties or schools. Grants in aid range from 300 to 400 rubles a month to 800 ($200) for graduate students. Students pay 25 rubles a month for their room.

The facilities proper provide further testimony of Soviet seriousness in an effort to surpass the West in the West's own pretension at superiority in this field. The University's new campus and buildings cost 3 billion rubles, or $750,000,000. Though this is not much compared with their military budget or ours, it dwarfs by contrast the cost of the best of American campuses and facilities.

This whole impressive development is set off by the Soviet pride in the dedication to public service implicit in their students and system. However one may feel about the role of propaganda and the thin distinction between encouragement, compulsion, and coercion, he is impressed with the evident and almost universal will to serve that is present in the Soviet student. Rarely does one hear mentioned the senior "saga" of many American students, "What is the starting salary? What are the fringe benefits?" More generally the question is, "Where am I needed?" This dedication, coupled with the social system, makes it easy to put talent in the most strategic place for national security and development. Fed by continu-



All photos courtesy of the Embassy of USSR

Under the direction of their mathematics teacher, tenth-form pupils of a Moscow school are preparing models of geometrical forms for a course in solid geometry.

ing fears of the West, continuing "curtains", diplomatic and immigration blocks to free interchange on the Russians' part and ours, the system is fortified by a sense of urgency that makes our effort to match Sputnik seem curiously shallow and misguided.

Wherein the Challenge?

What, then, does this say to us? Wherein does Soviet success challenge us? Ironically, one must say in the presence of present trends and developments that it challenges us precisely at the points where we do not feel it, and diverts us into a response which, because it mirrors Soviet methods without the same degree of motivation and meaning, is either doomed to failure or to national perversion. How is this so?

(1) The clue to the radical social and scientific progress of the Soviet Union lies not only in its mastery of scientific method but in the dedication, sense of historic mission, and faith-commitment that constitute its driving power and chief end.

(2) The success in transforming students into social servants, arguments of coercion notwithstanding, testifies that the Russians understand remarkably the relation between faith and learning, means and ends, value commitment and scientific advance.

(3) The peril of our response lies in our false presumption that the clue to competition in scientific and satellite success is to provide more science study (important as that is) without any substantial attention to the crucial problem of motivation and meaning.

(4) A further peril lies in the temptation to substitute for valid motivation of the student a type of political pressure and prestige, after the fashion of the Soviet system, in order to match her.

(5) Our most grievous miscalculation is our seeing the need for relating motivation and end to the method of scientific study but our failing to see the dramatic difference in *kind* of both motivation and end in our democratic free society, rooted in strong and diverse religious traditions which cannot be ignored as unscientific or supplanted by devotion to the state as in the Soviet system.

(6) The implications of the Soviet success in the face of these factors are thereby missed, or her methods mimicked, and either case is fatal for our own heritage and creative response.

A New Plan of Attack

Is there no other way? The present writer believes there is; and one more consistent, not only with our national character but with the deepest intent of our education and the values we prize. Some of the elements of such a way would be:

(1) To recover the sanity which sees that all education, scientific or artistic, is deeply related to the motives, values, and historic destiny of *persons*, and that how we interpret the nature, powers, and possibilities of persons shapes the dynamic as well as the direction of our educational disciplines, whether mathematics or music.

(2) To discover that any bankruptcy of education in America is not the product of failure in science, simply, to be corrected by more intensive studies in mathematics, physics, and the other sciences, important as these are, but is a more profound failure at a deeper level, the failure of a sense of historic destiny, of a basic motivation and dedication that brings the learning process alive.

(3) To discover that there are other and more basic drives to learning than interest in profit or power, and that we can learn, even from "enemies", the vitality of the intent to serve.

(4) To discover that the fruits of higher education in America have grown from the roots, early planted but lately unattended, of a common culture in which the values of the classical and Judeo-Christian faith were enshrined and drew their life. It is to see further that these are values that the "scientific studies", Russian or American, do not provide. They are either presupposed, ignored, or rejected by both.

(5) To see that we need more, not less, scientific study, to be sure, but that the critical problem of our time is not only "sputnik launching" but human survival, requiring a complementary attention to the "human dimension" in motives, meaning, and subject matter.

(6) To see that a "scientific engineer" is not sufficient answer to our present challenge, and that a relevant understanding of human engineering, sensitive to man's nature, integrity, and possibilities, is *required*, not as an "arts college elective" but as fundamental to the role of responsibility assumed by the engineer in today's world.

(7) To see that beneath scientific successes and similarities of Russia and the United States are fundamental and far-reaching differences of motivation and meaning, and that critical understanding of these differences is *fundamental* to our scientific as well as general education, if not survival.

(8) To realize that there is no final contradiction between dedication and objectivity, personal faith and scientific endeavor, provided the *object* of one's dedication is not an idol (whether that of the state, the American way of life, or a partisan institution or party) but is truly ultimate and universal.

This leads us finally to see and say that the only object worthy of the dedication of a university and of free men is the Living Truth, universal and coherent in scope, open to all men on the same condition: that they hunger to know it in order to do her bidding wherever it leads them. Wherever the truth leads, it must be translated through personal dedication into the service of men—breaking down barriers, lifting their burdens, healing their divisions, enlarging their life—ushering them into a world society in which every man has a *right* and an opportunity to be fully and truly himself.

Scientific study will always be a substantial ally to this pursuit. But it will not presume more than it can provide, nor parade as a panacea for a fundamentally human problem rooted in man's motivation, meaning, and social responsibility. How to nurture, discipline, and educate the human spirit in this wider sense, turning scientific study into a handmaid of human help and hope, is the real challenge of our time. Where better to begin than in our colleges of engineering that bear the primary weight of this new interest?

Whether we shall, and in time, or not, no one knows. But no one can deny that civilization is *still* education's race with disaster, and man's last hope.

"WHY ARE YOU A TEACHER?"

by

Prof. E. B. Watson

This question, so frequently asked by students in those informal discussions which occur between students and faculty on the college campus, commands no simple answer. Before the professor can answer it, it is necessary to examine the reasons which may have prompted the query. Is it simply that the student is curious about why the engineer who is his instructor chooses to practice his profession by teaching rather than in some other manner, such curiosity stemming from the current emphasis on the demand for engineers in industry and the publicized disparity between academic and industrial salaries? Or, is the student seeking guidance and counsel as he appraises teaching as a possible career? Or, perhaps, the question reflects a sincere desire on the part of the student to understand the motives and character of his instructor so that he may more properly evaluate the nature of the relation which he can expect to exist between teacher and student. That this is a factor seems apparent by the continual emphasis placed by student groups on the promotion of more effective student faculty relations. These remarks, necessarily quite personal in character, are directed at the examination of those factors which have caused the author to choose teaching as a career, and are based upon a number of satisfying years spent in teaching in the College of Engineering.

Teaching's Creative Aspect

The function of the engineer is primarily creative. The design engineer applies fundamental principles of the physical sciences and the engineering sciences to create machines or structures to perform new and unusual functions; the research engineer designs new methods of analysis or experiment which result in the creation of new bodies of knowledge; the industrial engineer designs new methods of manufacture by which the results of engineering research, development, and design are translated into marketable products; and the sales engineer continually seeks to create new markets and new methods of distribution. But what more creative career can an engineer select than that of assisting in the training of young men and women for positions of future leadership? Through his influence, the teacher can multiply many fold his own creative powers as he succeeds in stimulating the student to independent and creative thought.

At this critical period when American prestige suffers as a consequence of Russian technological advances, it is apparent that the creative function of the engineer must be stimulated by all possible means. While a greater supply of engineers may be needed, if the vital technical problems facing our country are to be solved, of greater import is that each engineering graduate be better trained to think creatively in the application of the specific knowledge acquired during his college experience. There can be no question of the importance of the teacher's contribution to the solution of this problem, nor no lack of challenge to him to find

ABOUT THE AUTHOR

Professor E. B. Watson, faculty adviser of THE CORNELL ENGINEER, joined the University staff in 1940 as an instructor. Now an associate professor, he teaches a number of courses in the Heat-Power Department.

Professor Watson obtained his undergraduate training at the University of Rochester and the Master's degree from Cornell. He has done some work in industry with the Kendall Refining Company, as Adviser to the Sales Manager. He has also done consulting work for several other corporations.

Besides his work for THE CORNELL ENGINEER, Professor Watson serves on the Board of Managers of Willard Straight Hall and as an adviser of Pi Tau Sigma. He is a member of Tau Beta Pi, Phi Beta Kappa, Pi Tau Sigma, and ASME.

Photo Science Studios

Prof. E. B. Watson

more effective methods of stimulating the student to realize the maximum benefit from his academic experience.

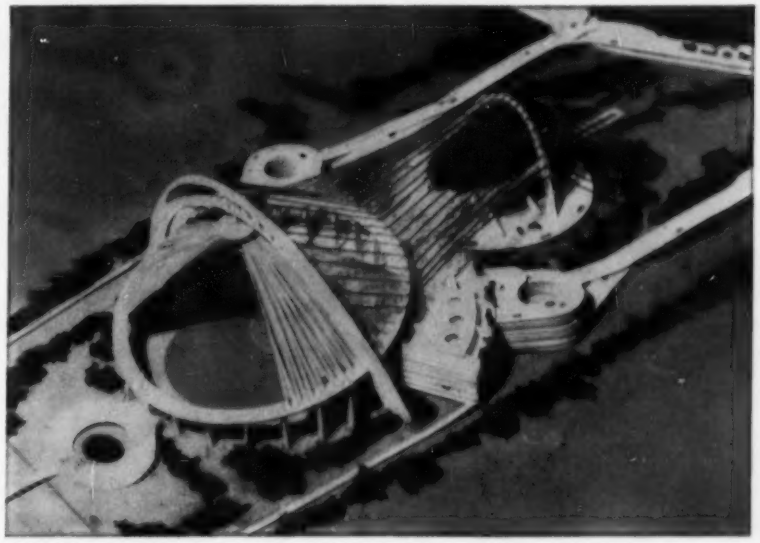
The Teacher's Responsibility

While the experienced teacher appreciates that his prime responsibility to the student is to assist him to master the subject matter of that phase of the curriculum for which he is responsible, he considers his ultimate role in the student's educational experience to be more than this. Important as is technical competence, this alone is not sufficient to guarantee that a student will realize his fullest potential or make his fullest contribution to society. By his precept and example, the teacher can hope to stimulate the student's development of those traits of character and personality which are the attributes of the educated man. Through interest in the student's welfare and willingness to provide personal counsel, the teacher may often exert a significant and lasting influence upon a student's overall development. As the teacher observes the parallel maturing of the intellect and the formation of principles which will guide the student in purposeful living, he can not help but find satisfaction in the thought that perhaps he has provided some stimulation and guidance.

"Why am I a teacher?" The most direct answer is probably that teaching provides an unlimited opportunity for working with people as well as with things. In finding solutions to the ever changing problems which arise as he attempts to stimulate, motivate, and guide young people through the educational process, the teacher finds unlimited opportunity for the full scope of his talents. Here is an opportunity for using the engineering approach to solve complex problems of human relations.

Despite the competition for his services, the engineering teacher remains at his post because he derives great satisfaction—often accompanying real frustration—from his relation with young people. The teacher realizes that he is performing a service of unparalleled importance since it is quite clear that the future of our civilization largely depends upon those studying in the classrooms today.

MARS outstanding design **SERIES**

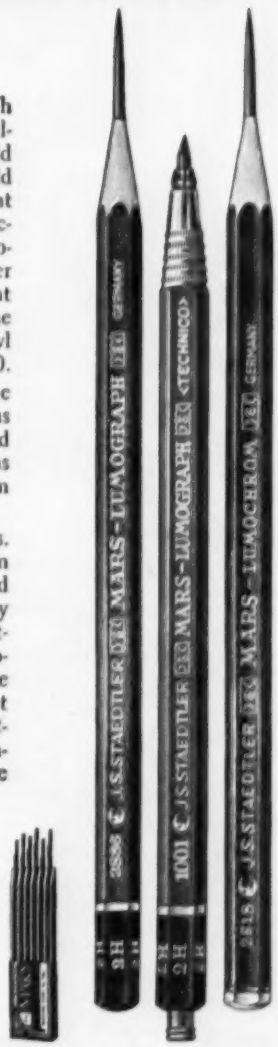


umbrella'd stadia

While it isn't always true, an interesting approach often results in a good design, as in these twin all-weather stadia designed by Harry Barone and Arnold Horn, Pratt architecture students. Each bowl would be umbrella'd by its own tentlike roof of translucent plastic, hung from the center of soaring arches. Accordion-pleated, these roofs are planned to fold together out of the way in fair weather, their lower edges riding along the rims of the bowls. Cables that guy the arches form a decorative pattern tying the two stadia together. The big football-baseball bowl would hold 65,000 spectators; the smaller, 20,000.

No matter which of today's bright ideas become tomorrow's reality, it will be as important then as it is now to use the best of tools when pencil and paper translate a dream into a project. And then, as now, there will be no finer tool than Mars—from sketch to working drawing.

Mars has long been the standard of professionals. To the famous line of Mars-Technico push-button holders and leads, Mars-Lumograph pencils, and Tradition-Aquarell painting pencils, have recently been added these new products: the Mars Pocket-Technico for field use; the efficient Mars lead sharpener and "Draftsman's" Pencil Sharpener with the adjustable point-length feature; and—last but not least—the Mars-Lumochrom, the new colored *drafting* pencil which offers revolutionary drafting advantages. The fact that it blueprints perfectly is just one of its many important features.



The 2886 Mars-Lumograph drawing pencil, 19 degrees, EXEXB to 9H. The 1001 Mars-Technico push-button lead holder. 1904 Mars-Lumograph imported leads, 18 degrees, EXB to 9H. Mars-Lumochrom colored *drafting* pencil, 24 colors.

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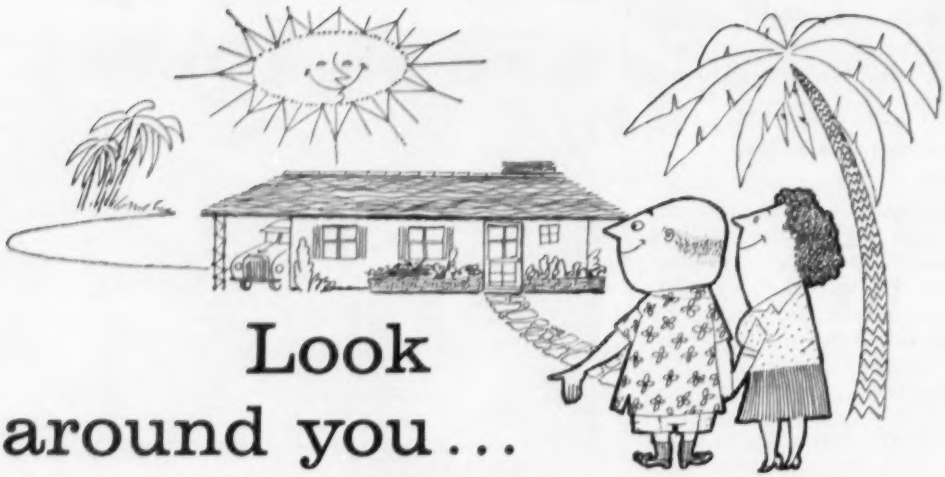
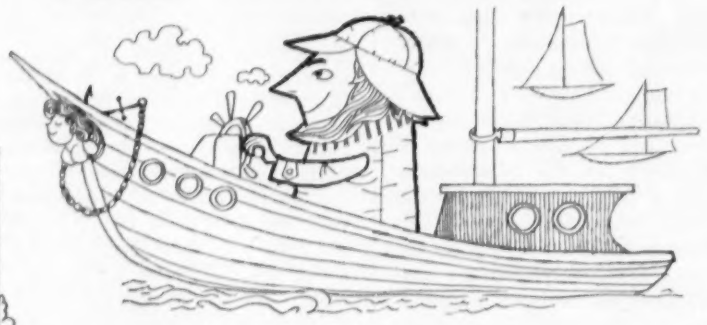
HACKENSACK, NEW JERSEY

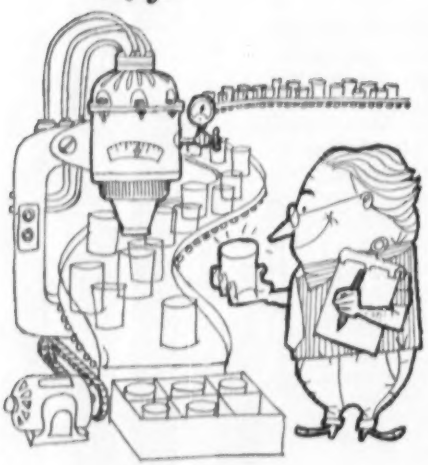
at all good engineering and drawing material suppliers



Look around you...

makes big things happen in paints and industrial finishes





You're living in a world of color. Man takes a brush, dips it into paint, cloaks the drab with new cheerfulness, converts the dreary into compelling beauty. But paint means so much more than mere color.

In addition to soft, pastel hues, home owners in Miami want a house paint that stands up to constant salt air breezes, the blazing rays of a tropic sun, intermittent heavy rainfall. Building superintendents in Gary want a surface coating unaffected by chemically active industrial gases and fumes, extremes in humidity, frequent changes in wind direction. Fishing fleet operators around Puget Sound want an exterior boat finish that resists biting winds, blizzards and protracted cold. The production engineer in a large Atlanta cannery wants a food container coating impervious to chemical reaction, yet taste-free. Yes, there's more—much more—to paint than mere color.

The search for new and even better paints and industrial finishes is carried on every day at Pittsburgh Plate Glass Company. Each day brings new challenges to its laboratories . . . challenges quickly translated into improved products.

Seeking a career that requires creative thinking, utilizes all your skills and talents, offers the chance to learn the latest techniques? Then look into your career possibilities with Pittsburgh Plate Glass Company. Contact your Placement Officer *now* or write to the Manager of College Relations, Pittsburgh Plate Glass Company, One Gateway Center, Pittsburgh 22, Pennsylvania.

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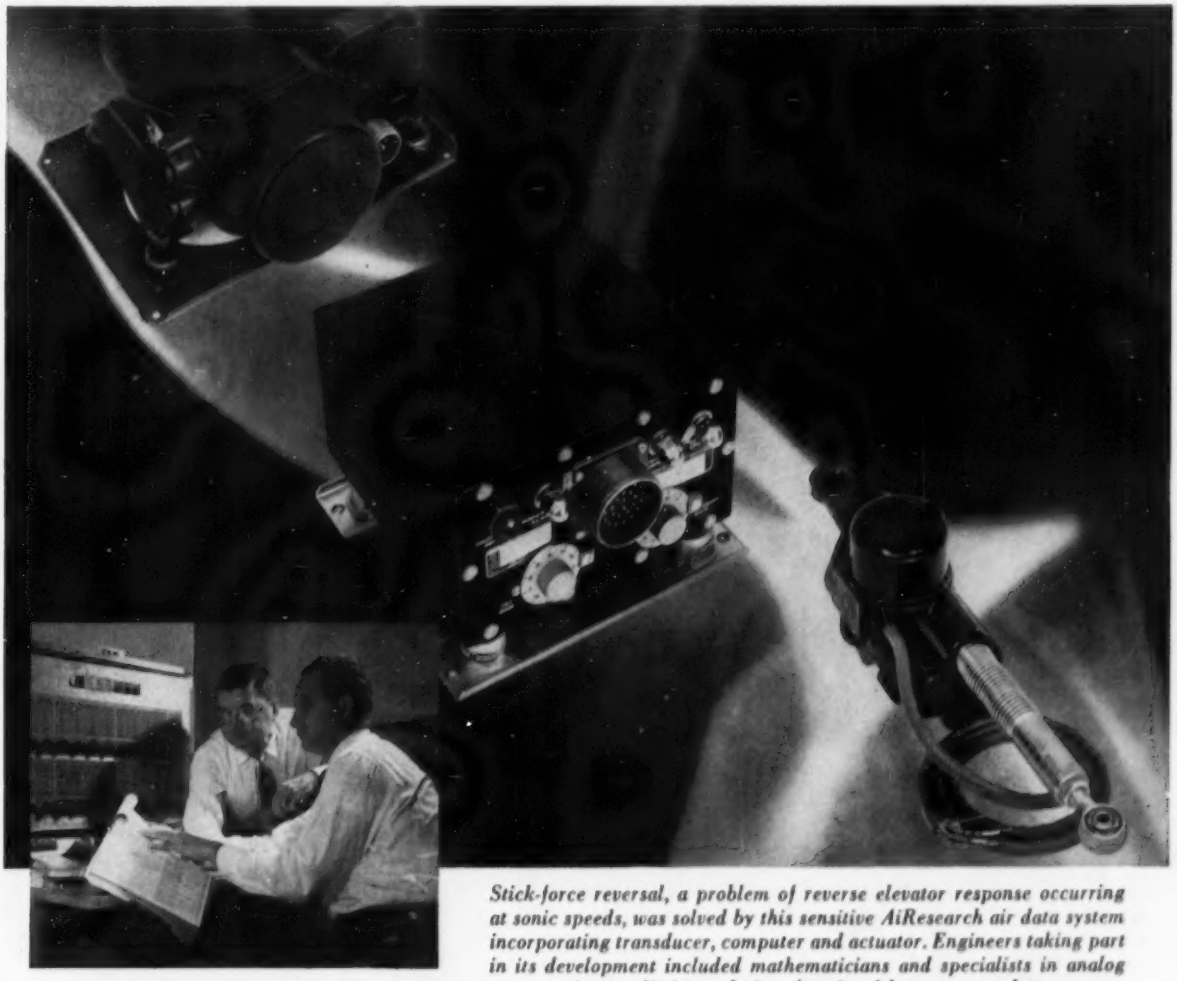
PITTSBURGH PLATE GLASS COMPANY

IF college has sharpened your urge to know more...



Stick-force reversal, a problem of reverse elevator response occurring at sonic speeds, was solved by this sensitive AiResearch air data system incorporating transducer, computer and actuator. Engineers taking part in its development included mathematicians and specialists in analog computation, preliminary design, fractional hp motors and gears.

Your formula for advancement in present day technological industry is growth in knowledge and ability.

Applying this principle at Garrett, engineers are achieving outstanding reputations for excellence in the following aircraft, missile and industrial fields: air conditioning and pressurization; heat transfer; cryogenic and nuclear systems; pneumatic valves; controls and air motors; system electronics; computers and flight instruments; gas turbine engines and turbine motors; prime engine development and industrial turbochargers.

Upon employment, you may choose either a direct assignment or enter a 9 month orientation program which permits you to survey Garrett engineering activities to aid you in selecting your field of interest. With company financial assistance you can continue your education at neighboring universities.

Typical project work is done in small groups where opportunities for learning, added responsibility and advancement are enhanced. To receive full information write to Mr. G. D. Bradley

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Full-time, off-the-job GRADUATE

STUDY CENTER. New York's Coliseum Tower houses one of three special study centers set aside for W.E.'s Graduate Engineering Training Program. Other centers are in Chicago and Winston-Salem, N. C. Product design principles are one of the many technical subjects our engineers cover in *Introduction to Western Electric Engineering*, the first phase of the program.

ENGINEERING TRAINING
helps speed careers at Western Electric

Right now, Western Electric engineers are back "on campus" in a unique new Graduate Engineering Training Program. They're attending courses at special study centers established by the company in Chicago, New York and Winston-Salem, N. C. It's a rare chance to study advanced engineering and get full pay at the same time.

These "students" are guided by a teaching staff of top Western Electric engineers, outside experts and professors from leading universities. They're learning the latest technical developments . . . boning up on everything from manufacturing processes to computer applications.

When the program reaches its peak, some 2,000 to 3,000 Western Electric engineers will attend each year . . . studying in an atmosphere as close to a university graduate school as is practical for industry.

This engineering "university" was born because of the ever-increasing complexity of Western Electric's job as the manufacturing and supply unit of the Bell Telephone System. Today W. E. engineers are right in the middle of exciting fields like microwave radio relay, electronic switching and automation. Graduate engineering training is designed to spur their development and advancement throughout their entire careers.

How Graduate Engineering Training would work for you

The program gets under way after approximately six months on-the-job experience. First off:

1. A nine-week *Introduction to Western Electric Engineering* helps you learn about your W.E. engineering field, sharpens your skills in getting ideas across. Technical subjects include communications systems, product design principles, military electronic systems.
2. Another nine-week program, *General Development*, starts after your first year with us, helps broaden and strengthen your engineering background. Besides technical subjects like engineering statistics, measurements and instrumentation, and electronics, you receive grounding in human relations and the socio-economic importance of engineering.
3. To meet continuing needs for formalized technical training, *Advanced Development* offers four-week courses tailored to the individual needs of the engineers selected to attend. These courses are designed to help develop creative engineering abilities. Computer applications, switching theory, feedback control systems, and semi-conductor devices and circuits are sample topics covered in this phase.

Besides taking part in the Graduate Engineering Training Program, engineers are eligible for our Tuition Refund Plan for after hours study at nearby colleges.

In short, there's a unique opportunity at Western Electric to develop a professional career . . . and work in the exciting world of communications.

Western Electric

MANUFACTURING AND SUPPLY UNIT OF THE BELL SYSTEM

Knowledge born in the classroom often sparks on-the-job ideas. These engineers are working on transistor manufacturing problems.

OPPORTUNITIES FOR ENGINEERING GRADUATES

(Supervisory and administrative opportunities exist in each field)

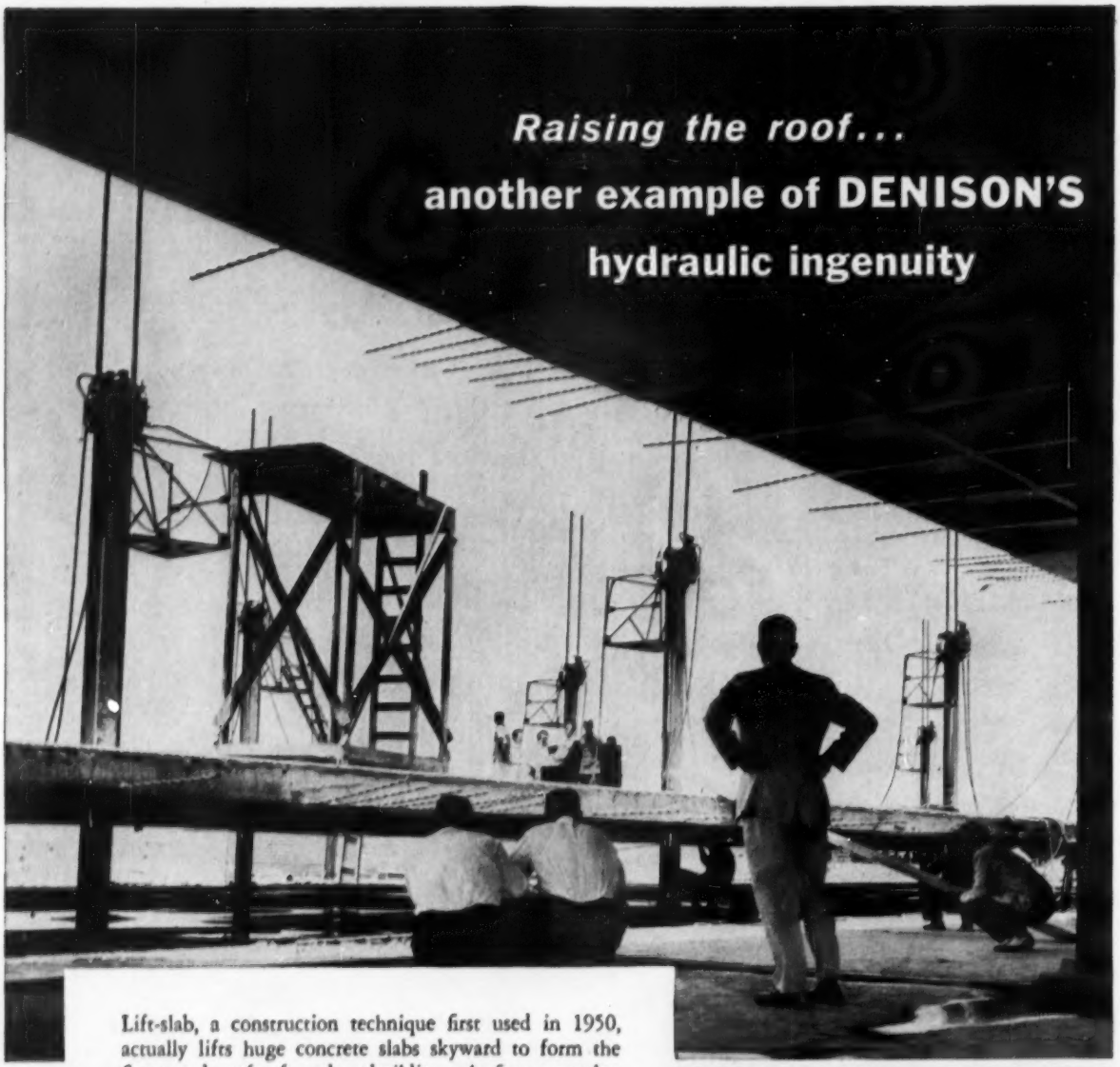
Analysis for manufacturing operations:
Machine and tool requirements—M.E., E.E.; Space requirements—M.E., I.E.; Test facility requirements—E.E.; Personnel requirements—I.E.; Electric power, light and heat requirements—E.E.; Raw material requirements—Chem. E., Met. E., Phy. Sc.; Procedures and processes—M.E., I.E., Time and motion studies—I.E., Investigation of manufacturing difficulties—M.E.; Quality control—M.E., E.E.

Planning telephone central offices:
Equipment requirements—E.E.; Power and cable requirements—E.E.

Development and design:
New machines and tools—M.E., E.E.; Material handling methods—M.E., I.E.; New equipment and processes—M.E., E.E.; Repair shop methods—M.E.; Testing facilities—E.E.; Testing methods—E.E.; Job evaluation studies—I.E.; Wage incentive studies—I.E.; Production control studies—I.E.; Improved chemical processes—Chem. E., Met. E., Phy. Sc.; New application for metals and alloys—Chem. E., Met. E., Phy. Sc.; Raw material test procedures—Chem. E., Met. E., Phy. Sc.; Service to military on electronic devices—E.E.

For further information write: Engineering Personnel, Room 1030, 195 Broadway, New York 7, N. Y.

• Western Electric has major manufacturing plants at Chicago and Decatur, Ill.; Kearny, N. J.; Baltimore, Md.; Indianapolis, Ind.; Allentown and Laureldale, Pa.; Burlington, Greensboro and Winston-Salem, N. C.; Buffalo, N. Y.; North Andover, Mass.; Lincoln and Omaha, Neb.; St. Paul and Duluth, Minn. Distribution Centers in 32 cities. Installation headquarters in 16 cities. General headquarters: 195 Broadway, New York, N. Y. Also Teletype Corp., Chicago 14, Ill.



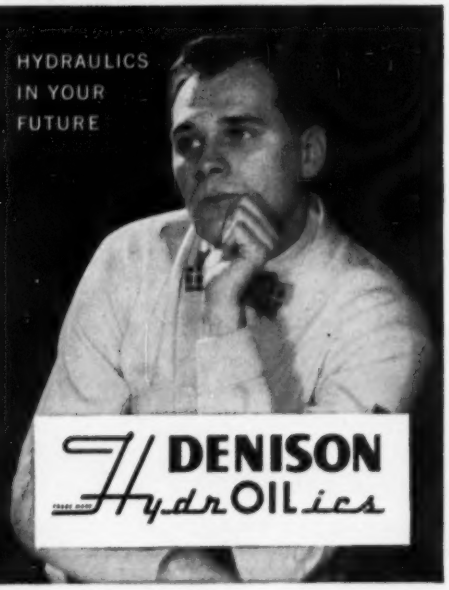
Raising the roof...
another example of DENISON'S hydraulic ingenuity

Lift-slab, a construction technique first used in 1950, actually lifts huge concrete slabs skyward to form the floors and roofs of modern buildings. At first a novelty, the lifting of 500-ton slabs thirty feet in the air *and more* is now an everyday occurence.

The technique is simple. Concrete slabs are poured individually at ground level, cured, and then lifted one at a time to proper elevation by a series of lifting jacks or screws. In each jack, a Denison hydraulic pump/motor furnishes constant, accurately controlled torque to follow up the lifting action of the jacks.

With dependable hydraulic power, the operation is, in every practical sense, foolproof.

Here is just one more instance where hydraulic power has been put to work for product or process improvement. Find out how hydraulics fit into *your* future. Write Denison Engineering Division, American Brake Shoe Co., 1218 Dublin Road, Columbus 16, Ohio.



DENISON HydrOILics

Look to **DENISON** *for leadership in hydraulic development*

"They all agree..."

"Since the day we decided to get married, I've been doing a lot of thinking about our future. It's time I made a choice on a career. I've talked to the Dean of Engineering, most of my professors, and to some of the fellows who have graduated, and you know, they all said the same thing.

"They all agree that the aircraft and missile industry holds the best opportunities and the brightest future for an engineer these days. What they said makes sense, too, because developments in this field today really give a fellow an opportunity to make important contributions on vital projects.

"Not only that, but the aircraft industry is noted for its good salaries. Generous benefits, too. And advancement in both salary and position is limited only by how far I want to go."

Unlimited opportunities, high salaries, company-paid benefits unheard of until a few years ago — these are only a few of the reasons why so many young engineers with a keen eye to the future are choosing the aircraft industry.

It is only natural that many engineering graduates should consider joining Northrop Aircraft, Inc., because the company shares its many successes with every member of its engineering and scientific team. Advanced projects at Northrop are now in production, and active top-priority projects mean rapid advancement and success for the individual engineer.

Such projects include the famous Snark SM-62, world's first intercontinental guided missile, now being activated in the first United States Air Force missile squadron; the USAF T-38 supersonic twin-jet advanced trainer; and other important missile and manned aircraft weapon systems and components.

Engineers in more than thirty categories contribute to Northrop's success in an ideal environment with the latest tools of science, in its new Engineering Science Center. Here you will work with leading scientists and engineers who respect, acknowledge, and reward your individual ideas and abilities.

Why not write us now . . . regardless of your class at college. Ask us how you might best gain a career with Northrop. Write to Manager of Engineering Industrial Relations, Northrop Division, Northrop Aircraft, Inc., 1033 East Broadway, Hawthorne, California.

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Roscoe H. Fuller

"The objects of this Society are to promote the welfare of the College of Engineering at Cornell University, its graduates and former students, and to establish closer relationship between the College and its alumni."

THE PRESIDENT'S MESSAGE—

MEN WANTED

The newly-graduated engineer for the past several years has been accustomed to competitive demands for his services, and as a consequence has enjoyed a considerably wider selection of opportunities for a career than was once the case. This, I think, is all to the good. The effect of increased demand improves the status of the whole profession, and the ability to pick and choose should result in each man being placed in the career best suited to his interests and potentialities.

The demand I am thinking of today is of a little different sort. It relates to a need for people both young and old to assume responsibilities in the collateral affairs of our civilization. In every community, whether municipal, social or scholastic, men are needed who will give of their time and energy to help make things go; to oil the wheels of progress, if you will. These are the fellows who serve on committees, who solicit assistance for worthy causes, and who hold the multitude of unpaid, unsung and thankless public offices.

There is little glamour involved in most of these activities; seldom any monetary reward and usually a considerable amount of painstaking effort. But the sense of a job well done, of duty performed at some personal sacrifice, of making oneself a functioning part of a group, is a reward in itself.

One often hears criticism of those who "run things." "They" ought to have more sense than to do this or that. Why isn't this or that done in a more efficient, sensible way? You have all heard remarks of this tenor; probably have made them yourselves. Why, indeed? Ill will? Ineptitude? Possibly. More likely, because the overworked and harassed individual trying to get the job done is so short of time and assistance that he just can't do any better under the circumstances obtaining.

Within you lies the solution. Every level of community effort needs able minds. At every level there are vacancies crying for able, intelligent people to fill them. Who better can do these things than people like you: people with rational, objective minds, trained in the finest engineering tradition?

The opportunities for service are innumerable. It usually takes but a small show of interest on your part to be welcomed into whatever line of activity appeals to you. Municipal work in a dozen different fields, charitable work, church work, club work, committee work, or work for Cornell; all need men. More pointedly, all need you. No one can do all these things, of course, but the choice is wide enough for you to find one you like, and the demand is great enough that there need be little fear of being rebuffed.

"Men wanted," yes. Good men are urgently needed. What better men are there; what more able men than the Cornell engineers who read this column? It is a sellers' market, and duty calls. Roscoe H. Fuller

ALUMNI ENGINEERS

Frank B. Campbell, CE '28, is chief of the Hydraulics Analysis Branch, Corps of Engineers of the US Waterways Experiment Station, Vicksburg, Miss. This summer he attended the Seventh Congress of the International Association for Hydraulic Research in Lisbon, Portugal, following which he toured a number of outstanding hydraulic laboratories on the Continent. He also is chairman of the committee on research, hydraulics division, of the ASCE. During World War II, Frank was executive officer of the 13th Naval Construction Battalion at Dutch Harbor, Alaska, and served as commanding officer of the 62nd Naval Construction Battalion both at Pearl Harbor and Iwo Jima. He holds the Bronze Star and Naval Unit Commendation. Frank has a son and two daughters, and lives at 1412 South Street in Vicksburg.

Arthur S. Griswald, BSME '22, was elected one of four new Detroit Edison vice-presidents. He has been industry assistant to Detroit Edison President Walker L. Cisler since 1952. He started in the Central Heating Department of the company in 1922 following his graduation from Cornell University. He has been active in electric utility industry organizations and for several years served as a government consultant on electric power to the Foreign Operations Administration and its predecessor agencies.

Arthur S. Griswold

Thomas M. Berry has been appointed General Superintendent of the Shaft and Tunnel Department for Dravo Corporation, Pittsburgh, Pa.

In his new capacity, one of Mr. Berry's principal responsibilities will be to supervise all construction on the 10 miles of tunnel being built by Dravo for the Allegheny County Sanitary Authority's new sewage system project in the Pittsburgh area.

Prior to joining Dravo Corporation in 1948, Mr. Berry served as a staff engineer for the Iron and Steel Institute in New York City.

A graduate of Cornell University, Mr. Berry is a member of Tau Beta Pi, Chi Epsilon and Phi Kappa Phi fraternities.

Mr. Berry lives at R.D. 3, Coraopolis, Pa., with his wife and three children.

Wesley S. Corbin, ME '31, is chief engineer of Black Clawson Co. paper machinery division. He and his wife have celebrated their twenty-sixth anniversary. Their twins, Grace Ann, a secretary, and John, in the fourth year of architecture at Syracuse, are joined by a younger boy Bob, who is a 195-pound footballer. The family live at 110 Winslow Street, Watertown.

Floyd W. Hough, '19, 2412 North Columbus Street, Arlington, Va. Floyd recently demonstrated an electronic device called a Tellurometer at Cornell's Fuertes Observatory. Using electro-magnetic waves to measure long distances, it is accurate up to one part per million, and can be used very effectively in geodetic, photogrammetric, and highway surveying. It may even replace triangulation and measuring with a tape.

George H. Barnard, BSAE '49, is the manager of the Reactor Test Site Operation, Technical Operation at the Material Testing Reactor, Arco, Idaho.

T. M. Berry

Robert W. Jorgensen, BIE '29, has been elected chairman of the laminated products section of N.E.M.A.

Established as the National Electrical Manufacturers Association in 1926, N.E.M.A. is the trade association of manufacturers of electrical apparatus and supplies.

Jorgensen is vice president and director of plastic sales for The Richardson Company, Melrose Park, Ill.

While at Cornell, he belonged to Red Key and Pi Delta Epsilon and was on the track squad.

The laminated products section of N.E.M.A. which Jorgensen now heads is comprised of manufacturers of industrial and decorative laminates.

He joined Richardson as director of plastic sales in 1952 and was promoted to vice-president the following year, retaining his previous duties.

In addition to N.E.M.A., Jorgensen is a member of the Society of the Plastics Industry. His other memberships include American Management Association, American Marketing Association, Cornell Society of Engineers, and Executives Club of Chicago.

Jorgensen resides at 535 Walnut Street, Winnetka, Ill., with his wife and four children.

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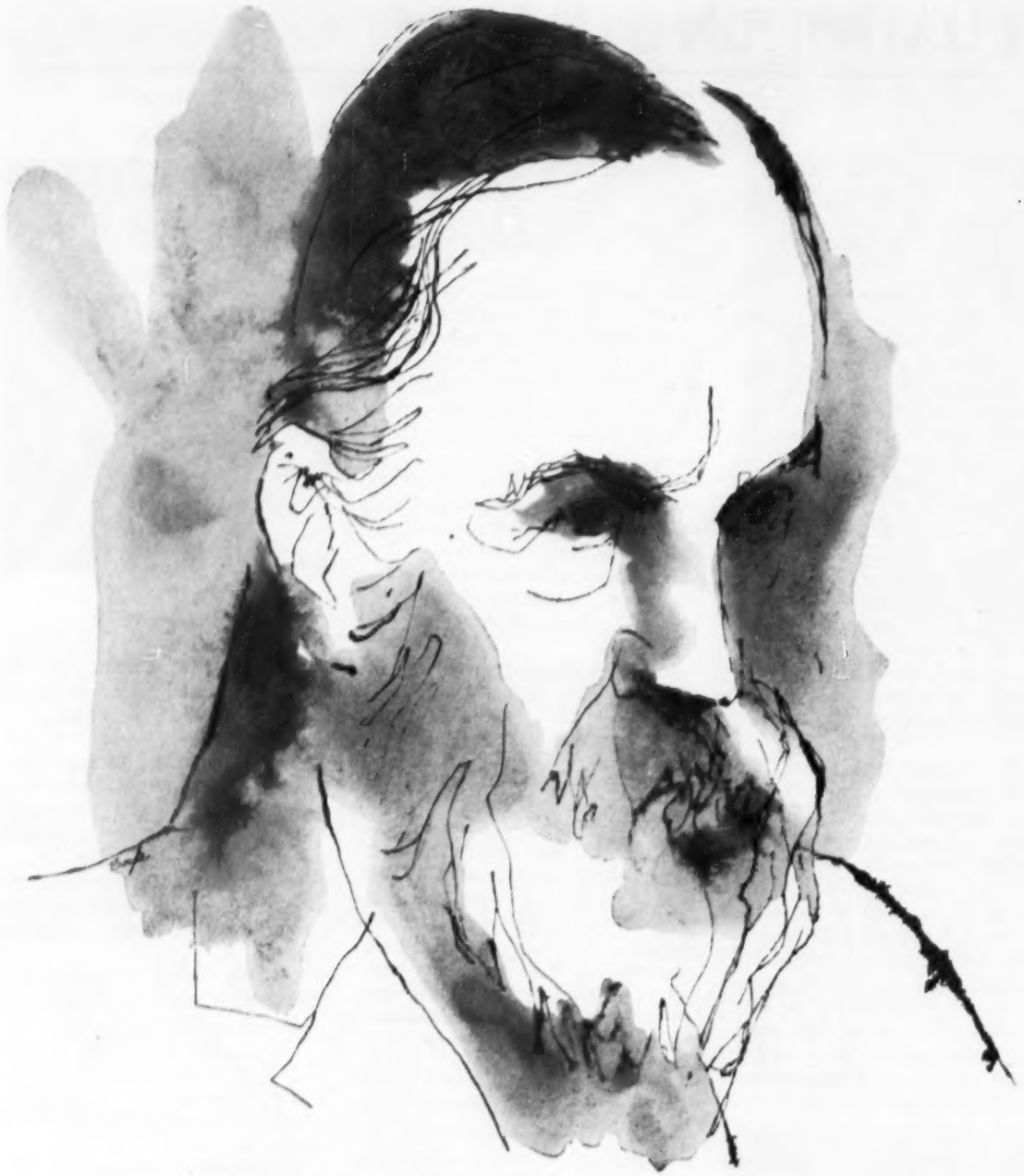
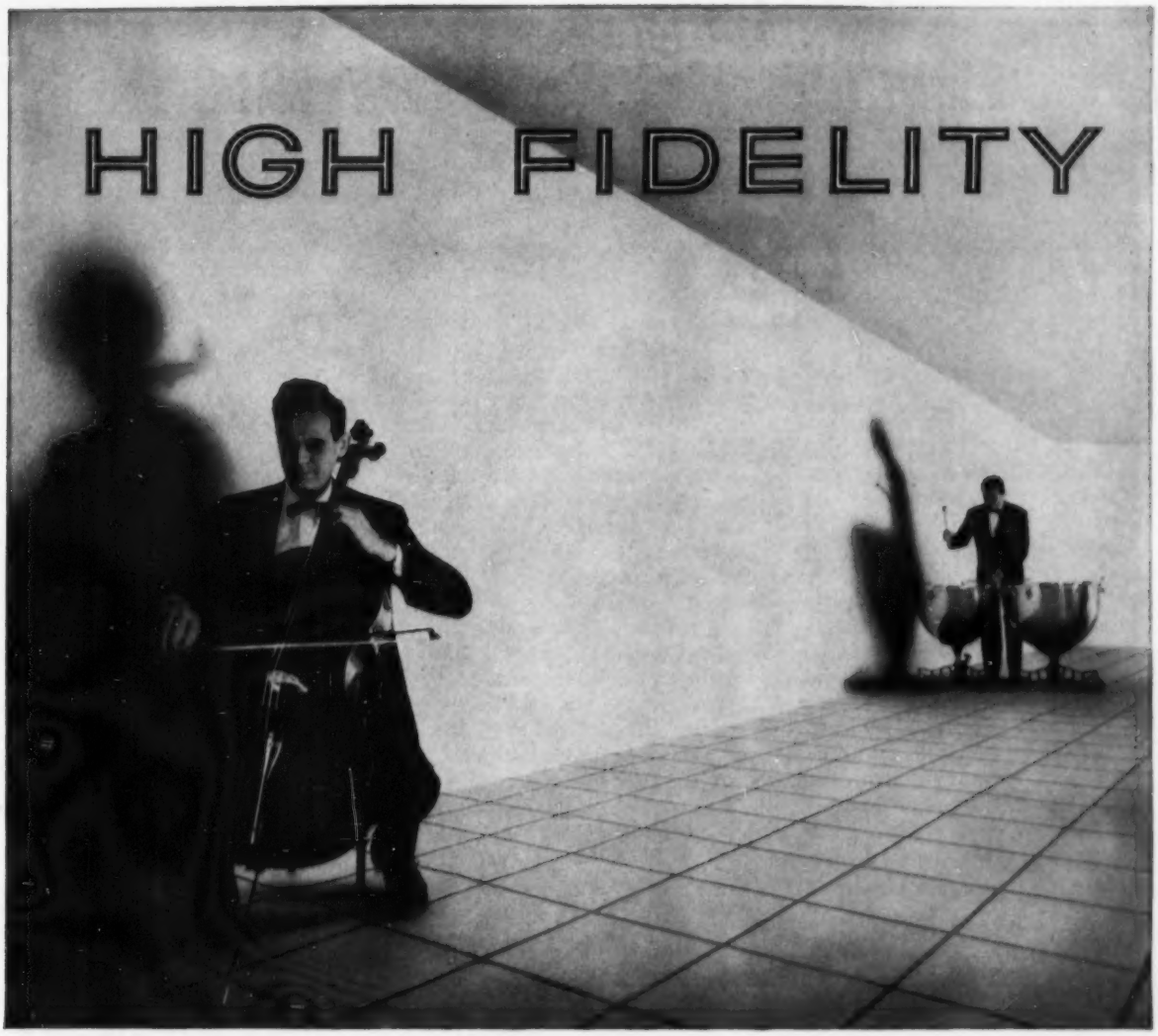


Ernst Mach...on absolutes

"No one is competent to assert things about absolute space and absolute motion; they are pure matters of thought that cannot be produced in experience. All our principles of mechanics, as we have shown in detail, are experienced knowledge concerning the relative positions and motions of bodies. They could not be, and were not, admitted in the areas in which they are now recognized as valid, without previous testing. No one is warranted in extending these principles beyond the boundaries of experience. In fact, such an extension is meaningless, as no one would possess the knowledge to make use of it."

—*Die Mechanik in ihrer Entwicklung, 1912*

THE RAND CORPORATION, SANTA MONICA, CALIFORNIA
A nonprofit organization engaged in research on problems related to national security and the public interest



How RCA brings a richer, wider range of musical sound to your home

Before high fidelity, the sound of recorded music was limited—much as piano music would be if you could hear only the notes played on the center of the keyboard. No rich bass notes, no keen, vibrant highs.

RCA achievements in the science of sound and acoustics changed all that. Today, with RCA Victor records and high fidelity "Victrolas," the *full range* of sound is reproduced so faithfully that you can enjoy music almost as though you were *there*.

And now, Stereophonic Sound! A new and dramatic dimension in recorded music is also yours to enjoy on RCA high fidelity instruments. Stereophonic units can be added to most "Victrola"® Hi-Fi systems any time you choose.

In this, as in almost every area of electronic progress in home entertainment, defense and industry, the leadership of RCA serves you. RCA *means* electronics at its best!

WHERE TO, MR. ENGINEER?

RCA offers careers in research, development, design, and manufacturing for engineers with Bachelor or advanced degrees in E.E., M.E. or Physics. For full information, write to: Mr. Robert Haklisch, Manager, College Relations, Radio Corporation of America, Camden 2, N. J.

RADIO CORPORATION OF AMERICA

TECHNICAL WORK IN EUROPE, ASIA, AND AFRICA

Do you want to go abroad next summer to Asia, Africa or Europe? Engineering and science students can obtain technical employment during the summer vacation in any of twenty foreign countries through participation in an international technical student exchange program.

The organization which makes this unique summer experience possible is IAESTE (pronounced i-yas'-tee), the International Association for the exchange of Students for Technical Experience. IAESTE was founded to train advanced undergraduate and graduate technical students in the industrial techniques of other nations. Further, the program functions to increase the student's understanding and appreciation of the country in which he is working. The student becomes for a short time a member of a foreign community, living and working with its members and getting to know them intimately. As a recent American trainee in Germany pointed out, the experience makes one realize "that many of today's international problems are the result of ignorance and misunderstanding that can only be alleviated through education and extended contact between the peoples of different nations."

IAESTE consists at present of twenty-three nations in Asia, Africa, Europe and America. It was founded in 1948 by nine European countries, in the hope that the disorganized and sporadic exchange that then existed between the member countries could be integrated and extended. The Association's success is shown by the nearly six thousand students exchanged among the member nations last summer, a sixfold increase over the 1948 figure. A total of over 34,000 students have participated in the program since its establishment ten years ago.

United States participation in IAESTE in the past has not been very great. Although over eighty per cent of the American applicants were placed in jobs abroad last year, only 82 American students participated in the program. Eighty-six foreign students were employed here. Foreign students in many fields of study, however, consider placement in the United States highly desirable, due to American leadership among the Western nations in so many technical fields. The biggest problem facing the expansion of American participation in the program, according to Josef Wischeidt, Secretary of the American IAESTE committee, is "to sell American industry—that's what we're working on now." Many American industries are reluctant to hire foreign students for the summer since there is no possibility of re-employing them. Those industries which have accepted foreign students, however, have found such participation extremely worthwhile. According to one industrial representative, "We can learn as well as teach. It gives our younger technical personnel, in particular, a chance to exchange ideas with persons having varied training backgrounds." Another company had the following impression of their foreign trainees: "These men are doing an excellent job, they are meeting our requirements, there is no added expense to us in having them as part of our organization and we are doing an important service by promoting wider understanding of engineering on an international scale."

The American student participating in IAESTE may go to Austria, Belgium, Denmark, Finland, France, Germany, Great Britain, Greece, Iceland, India, Israel, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, Yugoslavia or the Union of South Africa. At the annual IAESTE conference, which is attended by representatives from all member nations, job offers from industries are matched with applications, and the student is placed whenever possible in the country of his first choice. Once the student

(Continued on Page 72)

KLM Royal Dutch Airlines

These fifty-three technical students are about to leave for Europe to their summer job under the international exchange program called IAESTE. This specially chartered airliner left New York International Airport to take the students to on-the-job training with some of the continent's biggest business concerns.

We want engineers who like to

WORK

We have plenty of it to be done. We have problems to be licked, and questions to be answered.

Want to roll up your sleeves and tackle the fascinating world of petrochemicals? Union Carbide makes almost 500 of them—it's a world leader.

Want to grab the atom by the tail and put it to useful work? Union Carbide's been in nuclear energy since the earliest days of the Manhattan Project. It operates three AEC plants plus Oak Ridge National Laboratory, and is building a private nuclear research center near New York.

Want to dig in and really get down to the basics? Union Carbide is as basic as an industry can get. It's been called "chemist to the chemicals industry and metallurgist to the metals industry."

Representatives of Divisions of Union Carbide Corporation, listed below, will be interviewing on many campuses. Check your placement director, or write to the Division representative. For general information, write to V. O. Davis, 30 East 42nd Street, New York 17, New York.

BAKELITE COMPANY Plastics, including polyethylene, epoxy, fluorothene, vinyl, phenolic, and polystyrene. J. C. Older, River Road, Bound Brook, N. J.

ELECTRO METALLURGICAL COMPANY Over 100 ferro-alloys and alloying metals; titanium, calcium carbide, acetylene. C. R. Keeney, 137—47th St., Niagara Falls, N. Y.

HAYNES STELLITE COMPANY Special alloys to resist heat, abrasion, and corrosion; cast and wrought. L. E. Denny, 725 South Lindsay Street, Kokomo, Ind.

LINDE COMPANY Industrial gases, metal-working and treating equipment, synthetic gems, molecular sieve adsorbents. P. I. Emch, 30 East 42nd Street, New York 17, N. Y.

NATIONAL CARBON COMPANY Industrial carbon and graphite products. PRESTONE anti-freeze, EVEREADY flashlights and batteries. S. W. Orne, P. O. Box 6087, Cleveland, Ohio.

SILICONES DIVISION Silicones for electrical insulation, release agents, water repellents, etc.; silicone rubber. P. I. Emch, 30 East 42nd Street, New York 17, N. Y.

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COLLEGE NEWS

NEW PROFESSOR OF APPLIED MATHEMATICS APPOINTED

Prof. Henry D. Block has been promoted to associate professor of applied mathematics in Cornell University's Department of Engineering Mechanics and Materials, it was announced by Deane W. Malott, president of the University.

Before coming to Cornell in 1955, Professor Block taught at Iowa State College and the University of Minnesota. He became assistant professor at Cornell in 1956.

Professor Block received the BS and BCE degrees at City College of New York, and the MS and PhD degrees at Iowa State College.

Professor Block is a member of the American Mathematical Society, the Mathematics Association of America, Phi Beta Kappa, Phi Kappa Phi, Tau Beta Pi, and Sigma Xi.

PROF. HEWITT NAMED NEW CE ASSOCIATE PROFESSOR

The promotion of William Leonard Hewitt to associate professor of Civil Engineering in Cornell University's School of Civil Engineering has been announced by Deane W. Malott, president of the University.

Professor Hewitt became assistant professor of civil engineering at the University in 1953. He received the BCE degree from Cornell in 1948, then joined the faculty as instructor in drawing and surveying. He received the MCE in 1950 and in 1951 was a distribution engineer with the Binghamton Gas Works.

From 1951-53, he did work on subsurface exploration and soil testing for Hough Soils Engineering Laboratories in Ithaca, returning to the University in 1953 as assistant professor. Presently, Professor Hewitt is also head of the drawing department, admissions officer in the School of Civil Engineering, and freshman advisor.

He is a member of the American Society of Civil Engineers, having served as its secretary-treasurer from 1953 to 1954. He is also a member of Tau Beta Pi, engineering honorary society, Chi Epsilon, civil engineering honorary society, and the American Society for Engineering Education.

BUBBLE CHAMBER DONATED TO NUCLEAR STUDIES LAB

The General Electric Research Laboratory, Schenectady, N.Y., has donated a "bubble chamber" to the Laboratory of Nuclear Studies at Cornell. The heart of the bubble chamber is a glass-ended cylinder about six inches in diameter, containing liquid hydrogen, in which the tracks of fast-moving nuclear particles may be observed.

"This bubble chamber donated by the General Electric Company will enable our laboratory to perform many types of investigations which would otherwise not have been possible," said Dr. Robert R. Wilson, director of the Laboratory for Nuclear Studies.

Among the projects for which the bubble chamber will be used are studies of the properties of nuclear particles called "K-mesons" that are produced by the University's 1.1 billion-electron-volt synchrotron. Previous investigations of these particles led to the discovery of the unsymmetrical nature of laws of physics, for which Drs. Lee and Yang of Columbia University and the Institute of Advanced Study at Princeton have recently been awarded the Nobel Prize. Some of the experiments which are planned to be performed with the bubble chamber will be related to this violation of the law of parity.

The principle on which the chamber operates is that if a charged particle passes through liquid hydrogen it leaves a trail of ions (other charged particles) behind. If the pressure on the liquid hydrogen is then suddenly reduced, the liquid hydrogen begins to vaporize and these newly formed ions serve as the nuclei of bubbles of hydrogen gas. This line of bubbles can be photographed, and the properties of the particle which made the track can be determined by the length of the track and the number of bubbles along it.

Although inherently a simple device, the bubble chamber as actually constructed is highly complex because of the need for accurately controlling the temperature and pressure of the liquid hydrogen and the requirement of a carefully designed optical system. The liquid hydrogen in the bubble chamber is maintained at a temperature of about 400°F below zero.

FOREIGN LANDS WELL REPRESENTED AT CORNELL

Foreign student enrollment at Cornell University is at an all-time high this year, with 640 graduate and undergraduate men and women registered from 78 countries. The total is 18.5 per cent above last year's figure of 540.

Approximately 24 per cent of all Cornell's graduate students are from foreign countries, with 421 registered. The combined graduate and undergraduate foreign student enrollment represents six per cent of the total Cornell student body.

The largest enrollment, 263, is in the College of Agriculture; there are 106 in the College of Arts and Sciences, and lesser numbers in other schools and colleges.

This year's registration shows an increase over last year's from every area of the world. There are 111 students from Europe as compared with 89 last year, 104 from Latin America as compared with 80, the Middle East has sent 53 as compared with 39 last year, there are 38 from Africa as compared with 33, the Far East is represented by 218 as compared with 208, and miscellaneous countries account for 116 as compared with 91 a year ago.

MUSIC SYNTHESIZER DEMONSTRATED AT AIEE

An electronic music synthesizer that can generate any tone produced by musical instruments or the human voice was demonstrated at the January meeting of the AIEE & IRE. Mr. Cyril N. Hoyler, manager of Technical Relations at R.C.A.'s David Sarnoff Research

Center showed the machine as part of his talk on "New Adventures in Electronics."

After explaining the important principles of the music synthesizer's operations, Mr. Hoyler played several excerpts of synthesized music to demonstrate its range and versatility. The R.C.A. Synthesizer was developed under the direction of Dr. H. F. Olson. Included in Mr. Hoyler's talk were several other demonstrations of research developments in the fields of electroluminescence, electronic refrigeration, television and acoustics.

M.E. IN THE MISSILE INDUSTRY DISCUSSED

Until the last two decades, the mechanical engineer was principally employed in product design, but today he can be found working as a theorist in basic research, electromechanical systems, electronic computing devices or as an industrialist, performing management functions. This opinion was expressed by Mr. I. Katz of the General Electric Corporation and a former assistant professor at Cornell in his talk on "The Mechanical Engineer in the Missile Industry" at the American Society of Mechanical Engineers' meeting on December 17.

The work that modern mechanical engineers are equipped to do can be divided into two categories, technical and managerial. Technical functions include advancing the state of the art, gaining knowledge, proving feasibility, obtaining data and improving the product. Management functions are organizing, integrating and measuring.

Mr. Katz pointed out that the opportunities for mechanical engineers in the missile industry are unlimited. A few of the problems facing M.E.'s in this field are motor design, heat transfer, combustion, temperature and pressure changes, guidance, launching and acceleration effects. He stressed the need, however, for college curricula to keep abreast of the times and to train people in the synthesis of complex devices. He warned against sacrificing engineering courses for more science, and urged more courses in machine design and exceptionally high speed bearings.

Communications, Mr. Katz noted, takes up about half of the engineer's time. The ability to write and speak well are essential if the engineer is to sell his ideas to his associates.

Engineers have definite responsibilities to the community as professionals, said Mr. Katz. They must be conscious of the effects of their work, whether they be social problems, hazardous risks such as nuclear wastes or the use of loopholes in legislation.

GRANTS FROM DU PONT TOTAL MORE THAN $41,000

Grants totalling more than $41,000 have been awarded Cornell University by E. I. du Pont de Nemours and Company in its annual program of aid to education. The company is distributing nearly $1,150,000 in grants to 135 universities for use during the next academic year.

The grants will support the teaching of science and mathematics, as well as other subjects, and will continue to aid fundamental research.

The Du Pont grants to Cornell are divided into six separate categories. The largest grant will provide $15,000 for fundamental research in chemistry, to be carried out in 1958-59 and in the summer of 1958. This is a renewal of a similar grant given last year. Under the terms of the grant, Cornell will determine the work to be undertaken, which must be of a fundamental nature. The researchers will be free to publish the results of their work.

A $12,000 grant to encourage able young people to undertake careers of teaching science and mathematics in high schools will provide six fellowships for recent college graduates. In making this grant, the Du Pont company declared: "The purpose is to encourage better teaching and to attract more qualified teachers. There has been a steady decline in the number of teachers in these fields while the future of the nation's scientific manpower and scientific education depends to a large degree on the number of well trained high school graduates."

Each fellowship carries a $1,200 living expense stipend, and an additional grant is made to the university.

A gift of $4,000 has been made to help maintain the excellence of teaching at Cornell. Of this sum, $2,500 will be for chemistry teaching, and $1500 for other courses. Both amounts may be used in ways which the university feels will most effectively advance instruction and stimulate interest in the subjects.

A fellowship for a postgraduate student in chemical engineering is established by a grant totalling more than $3,600. The fellowship provides $1,800 for the student—$1,500 if he is a first year student and $300 if he has a child or $600 if he has more than one child. In addition, tuition and educational fees are paid, and a contribution to Cornell of $1,200 is made.

CAL TO DO RESEARCH ON SURVEILLANCE SYSTEMS

A contract to provide the United States Army with scientific guidance for the improvement of combat surveillance of the battlefield has been awarded to Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y.

Under the two year study, a cooperative group will be set up in the Washington, D.C. area composed of CAL scientists and engineers in company with military personnel of the Army Combat Surveillance Agency.

The group will aim at establishing research and development programs for such systems and devices as are determined necessary to advance Army techniques of combat surveillance.

Combat surveillance is a continuous and systematic watch over a combat area under all conditions of weather, both day and night. According to a Laboratory spokesman, it has long been a neglected area for both large scale and limited war.

The contract, awarded by the Signal Corps, aims at improving systems of surveillance of a battlefield by radar, infra-red, sonic, meteorological, reconnaissance, photographic and televisional means. Such information is essential to Army commanders who may operate on battlefields covering thousands of square miles, and employ the devastating weapons of modern warfare.

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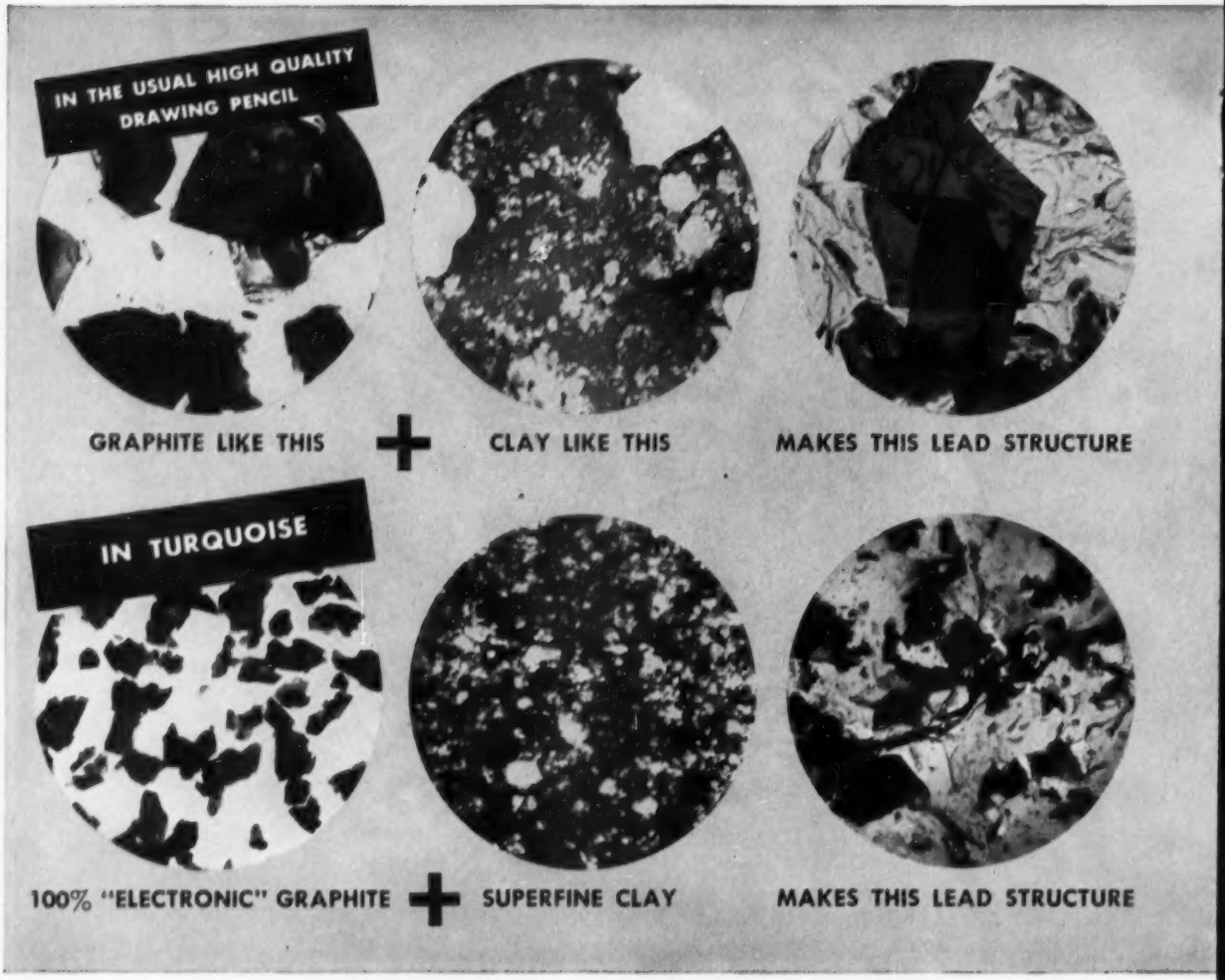

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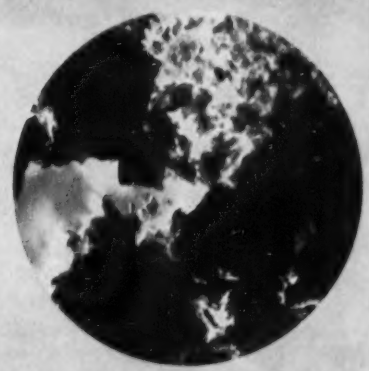
Photographs courtesy of Ladd Research Industries, Inc.



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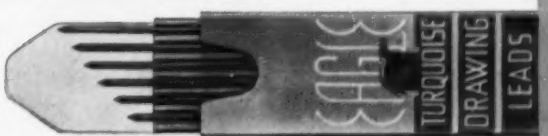

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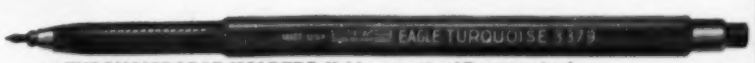

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TECHNIBRIEFS

ENERGY FROM TV SIGNALS POWERS TRANSISTOR RADIO

A transistorized radio receiver which operates on the power obtained from radio signals has been developed at the Army's Diamond Ordnance Fuze Laboratories. The radio energy taken from the air is stored in condensers that serve as storage batteries. The energy may be taken from a radio or television signal and even from the same station that the sound comes from. The power is sufficient to bring in programs on earphones and on loudspeakers when the set is near enough to the broadcasting station. It is believed that this type of system will provide enough power from the air to operate small pieces of equipment such as batteryless microphones to be worn by speakers moving about, or little transmitters in buoys that will send messages back to an approaching ship.

NEW DEVICE CHANGES HEAT DIRECTLY TO ELECTRICITY

A new device for changing heat directly into electricity without the use of moving parts has been built by the General Electric Research Laboratory. The instrument which is called a "thermionic converter" consists of two metal electrodes, one of which is kept at relatively low temperature, while the second is exposed to a very high temperature of about 2,500 degrees Fahrenheit. The heat boils electrons out of the metal. These electrons, made to flow in a stream through a wire conductor, create an electric current.

Thermionic converters combine several known scientific principles in a unique manner. The two electrodes, enclosed within a tube-like envelope, are maintained at different temperatures. New approaches to the design of the electrodes, the materials used, a gas environment within the envelope, have resulted in a more efficient flow of electrons than ever noted before in similar devices.

Experimental converters have changed more than eight per cent of the applied heat energy into electricity. It is not economically feasible at present, but with further refinements as much as thirty percent of the heat could be directly converted into electricity. Such efficiency may open the way to the conversion of the heat in a nuclear reactor directly into electricity and also to the harnessing of the energy of sunlight.

Most previous methods for converting heat directly into electricity have been based on the thermocouple, a device long used by scientists for measurement and control functions. One obvious difference between the new thermionic converter and the thermocouple is that the metals are separated by a gas at very low pressure. There is an electrical connection between the electrodes, but there is less flow of heat than through a metal. Thus the electrodes can be at different temperatures, and the efficiency greatly increased as the result of the reduction, and hence waste, in the flow of heat. This fact leads to the expectation that thermionic converters ultimately may be able to change more than thirty percent of the heat energy into electricity.

SEISMIC WAVES SHOW EARTH CONTAINS DENSE INNER CORE

Analysis of the records of seismic waves produced by the four hydrogen bomb explosions of 1954 have provided evidence for the existence of an inner core of the earth, of a radius of 800 miles, inside the central core. The analysis was made as the waves reached Australia from the proving grounds at Eniwetok in the Marshall Islands.

Until 1936, it was thought that the central core of the earth was of uniform composition. Then a Danish seismologist produced evidence of the existence of an inner core, of an 800 mile radius. Work in the United States and in England supported this conclusion as does the latest evidence supplied by the four hydrogen bomb explosions of 1954.

An early contribution of seismology was the precise location of a central core of the earth at a depth of 1800 miles below the surface, and with a radius of approximately 2,200 miles. The region above the central core is called the mantle of the earth.

There are two types of waves which travel from a "focus" downward into the earth. These are primary, or P-waves, in which the particles move longitudinally; and the S, or secondary waves in which the particles move transversely. In solids the P-waves travel 50 percent faster than S-waves. P-waves will travel entirely through the earth in 20 minutes and 12 seconds. Fluids do not transmit S-waves noticeably. Therefore those parts of the earth found to transmit both S and P waves are solid. Failure to detect S-waves is evidence that the part of the earth concerned is fluid. Analysis of these waves yields values for the variation of density, gravity and pressures in the earth.

Nuclear explosions as well as earthquakes send seismic waves into the earth's interior, but waves produced by nuclear explosions are of greatest advantage because the exact location and time of origin are precisely known.

SANDWICH PROCESS ROLLS STEEL TWICE USUAL WIDTH

A break-through in the rolling of stainless and alloy steel sheets has been accomplished experimentally by a "sandwich" rolling process. This method has produced steel sheets up to ninety inches wide—nearly twice the width of light-gage stainless and alloy sheets now being made by conventional methods.

Translated to terms of aircraft material and design, the wide sheets are an avenue toward more rapid production and less weight. Where aircraft requirements call for alloy and stainless steel sheet wider than now available, these material limitations require joining of two or more sheets. As more and

more alloy and stainless steel is used in aircraft and missiles, wide sheets offer a significant saving in weight, plus design and fabrication simplification.

A typical steel "sandwich" consists of two carbon steel cover plates each 5/16-inch thick and treated with a separating compound. The sandwich is held together with welded-in side and end bars. Prior to rolling, the sandwich is about three inches thick.

Heated to high temperature the sandwich is put through a rolling mill. Reduced each time it passes through the massive rolls, the sandwich becomes progressively thinner, longer and wider until it is a plate approximately three-eighths inch thick, a hundred inches wide and two hundred fifty inches long.

In the rolling process each layer of the sandwich undergoes the same amount of reduction in thickness. Rolled to a total reduction of 90%, the 5/16-inch thick stainless steel plates are reduced to a nominal thickness of .033 of an inch each.

After cooling, the edges of the huge plate are trimmed and the thin-gage sheets are lifted from atop each other.

The "sandwich" technique, developed by United States Steel has solved several problems that have prohibited rolling of wide alloy and stainless steel sheets. Thin gage sheets rolled singly become cool quickly and require tremendous mill power to achieve reduction as the cooling goes on. Because of its initial thickness, the "sandwich" tends to retain sufficient heat for the entire rolling operation. In rolling, the sandwich has the working characteristics of the carbon steel cover plates rather than the tough stainless of alloy steels inside. This minimizes the need for excessive rolling mill power so that existing facilities may be used to experimentally produce these light gage alloy and stainless steel sheets.

PORTABLE INSTRUMENT NOW MEASURES EXPOSURE DOSE

A portable instrument has been developed for measurement of the radiation exposure dose, as agreed upon at the 1956 meeting of the International Commission on Radiological Units and Measurements, and for the comparison of this primary standard with the exposure doses of other countries. It can also be used to measure the gamma radiation from a radioactive source, which could then function as a temporary primary standard, allowance being made for its rate of decay. A set of equipment similar to that prepared for the ICRU has also been constructed for the United Nations Educational, Scientific, and Cultural Organization (UNESCO).

Although it is possible to compare the national primary standards with one another directly, this involves a great expenditure of time and effort and is therefore attempted only at infrequent intervals. The purpose of the present portable instrument is to make such comparisons possible on a more frequent basis while maintaining a reasonable level of accuracy.

Use of the transfer instrument is expected to bring about greater uniformity in radiation measurements, so that results obtained in different countries can be more easily and reliably compared. The direct benefits of this should be felt by those engaged in the many activities in which radiation now plays an important part; for example, in the control of therapeutic

(Continued on Page 72)

The Lincoln Electric Co.

BUILDING HUNG ON GIRDERS

This building is literally turned inside out, with four plate girders (two shown), columns and structural mullions outside the roof and plate glass walls. Virtually every connection in the 285 tons of structural steel is welded, partially in the shop, and partially in the field. The interior of the building containing 26,400 square feet of completely unobstructed area, features concealed air conditioning and recessed lighting. Mullions and columns form ten foot bays, each enclosed in floor-to-ceiling plate glass panels. The first building of this type ever built, it is located at The Illinois Institute of Technology.

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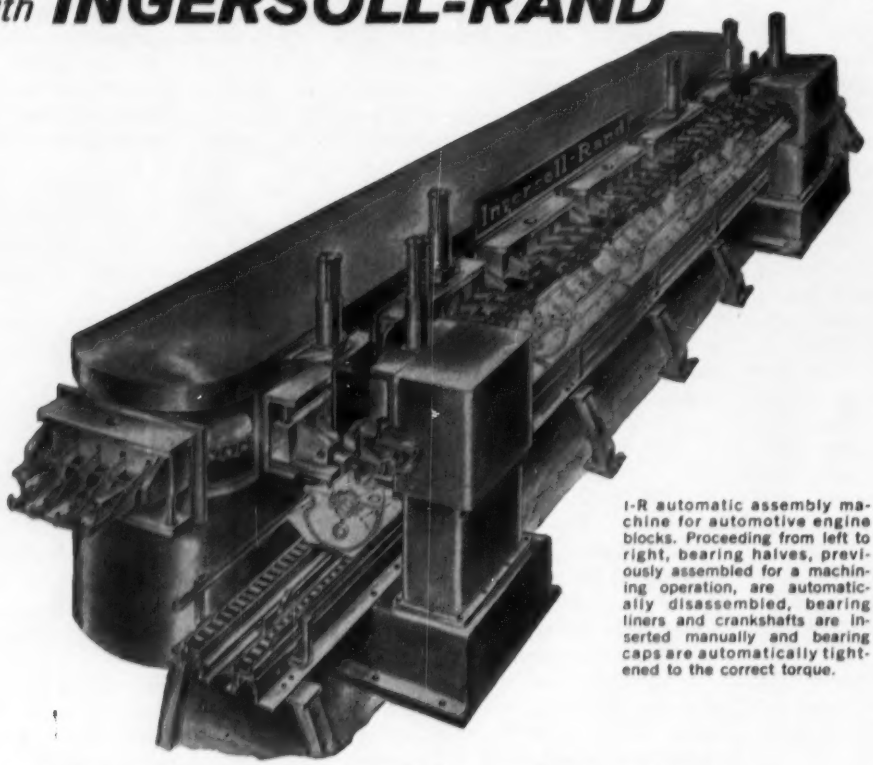

I-R automatic assembly machine for automotive engine blocks. Proceeding from left to right, bearing halves, previously assembled for a machining operation, are automatically disassembled, bearing liners and crankshafts are inserted manually and bearing caps are automatically tightened to the correct torque.

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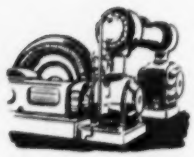
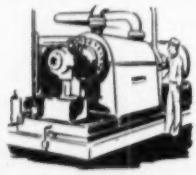


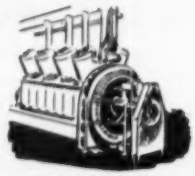
Compressors and Blowers



Centrifugal Pumps

Rock Drills

Steam Condensers



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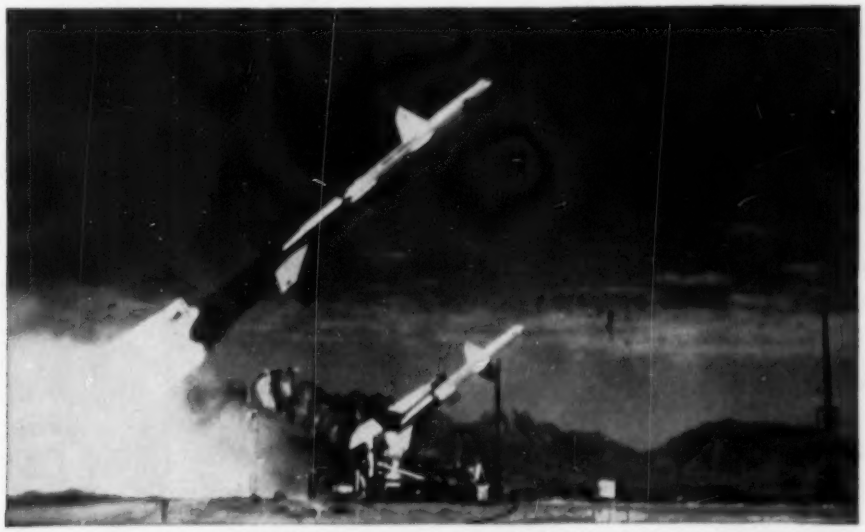

First uncensored photo of TALOS, long range guided missile developed by APL for the Navy.

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The Applied Physics Laboratory (APL) of The Johns Hopkins University exists solely to make scientific and technical advances. For this reason we are able to offer our staff members freedom to explore tangential ideas, which frequently lead to significant accomplishments. Among our "firsts" are the world's first supersonic ramjet and the first large booster rocket. As far back as 1948 we achieved fully-guided supersonic flight.

Today two guided missiles that grew out of our pioneer work are in production: the TERRIER is now a fleet service weapon, and TALOS (above) has been adapted for land as well as ship-based operation. When TALOS was recently unveiled by the Navy, APL shared honors with many associate and subcontractors who had worked under our technical direction in its development.

We are presently engaged in missile assignments of a highly advanced nature which cannot be divulged for security reasons. Suffice it to say that, as always, our work is of such vital importance and urgency that little is spared to facilitate its progress. Scientists and engineers at APL are in the vanguard of science and enjoy the keenest sort of responsibility and challenge.

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The Johns Hopkins University Applied Physics Laboratory

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CAN YOU FIGURE IT OUT?

A machine can turn out 20 "A" bulbs and 15 "B" bulbs per day. But, it takes 0.2 hours to make an "A" and 0.4 hours to make a "B." The profit on an "A" is $2 and on "B" $5. How many of each should be made per 8-hour day for maximum profit?

Sherman Francisco tells what it's like to be . . . and why he likes being . . . a Computer Systems Engineer with IBM.

✳ Solution at bottom of page

FIGURING OUT A CAREER?

Selecting a career can be puzzling, too. Here's how Sherman Francisco found the solution to *his* career problem—at IBM:

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***SOLUTION**

If x and y be the number of bulbs A and B respectively, the profit (P) for a day can be represented by

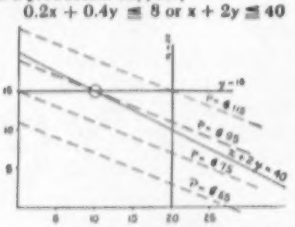
$$P = 2x + 5y$$

subject to the restrictions

$$x \leq 20, \quad y \leq 15$$

and also subject to the restriction that there are only 8 hours in a production day, i.e.,

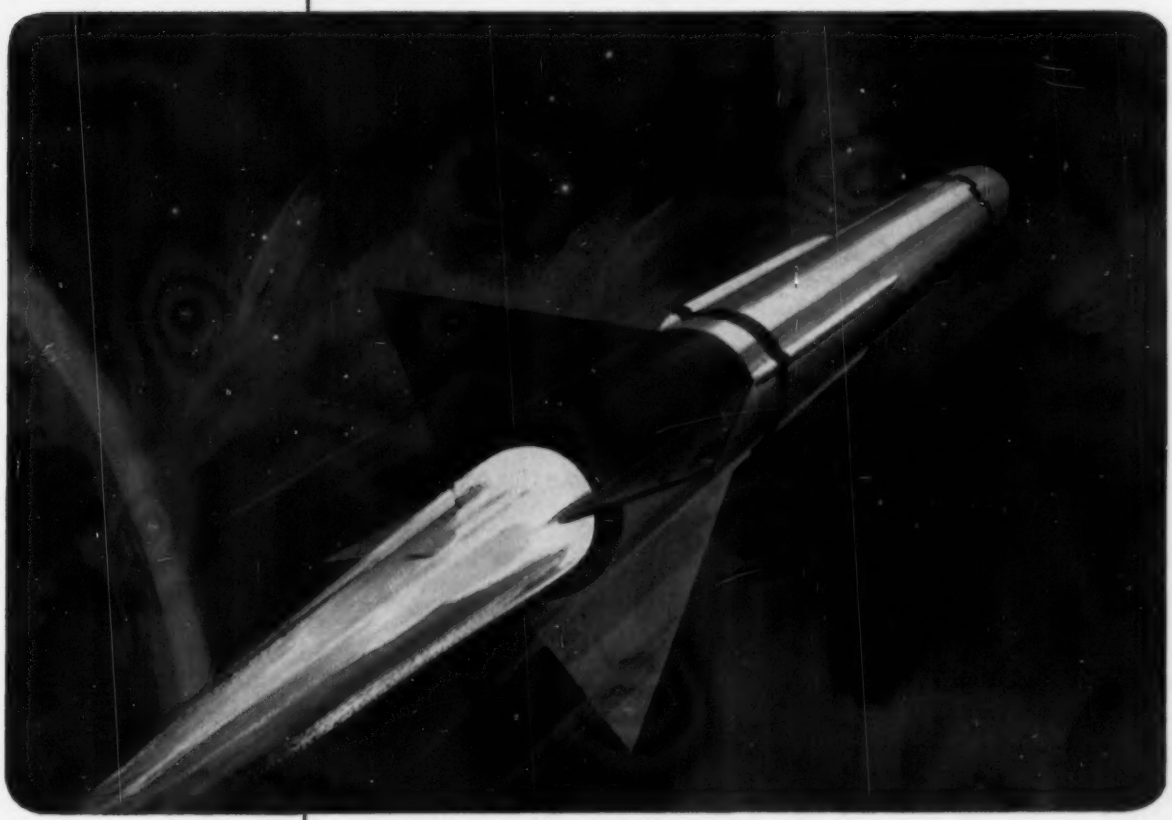
$$0.2x + 0.4y \leq 8 \text{ or } x + 2y \leq 40$$



Since $x \geq 0$ and $y \geq 0$, the values of x and y must fall on the boundary or within the polygon enclosed by the lines $x = 0$, $y = 0$, $x = 20$, $y = 15$ and $x + 2y = 40$, as shown. The optimal solution occurs at the corner where $P = \$95$. Thus the maximum possible profit is $P = \$95$ at $x = 10$, $y = 15$, i.e., when the machine produces 10 of A and 15 of B each day.

Note: This simple graph method is too cumbersome for more than 2 variables. Modern computers use numerical techniques to handle many more variables – a technique called Linear Programming.

IMPORTANT DEVELOPMENTS AT JPL



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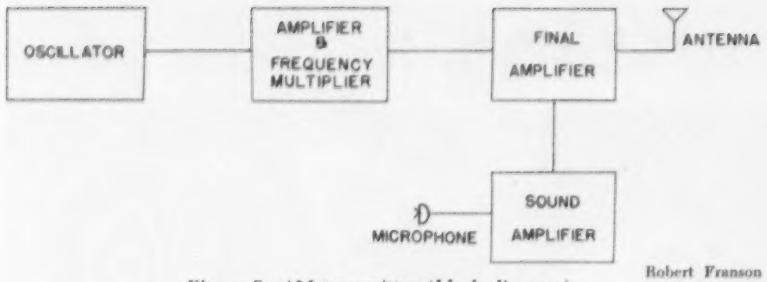


Robert Franson

Figure 5—AM transmitter (block diagram).

ON THE AIR FOR EVERYONE

(Continued from Page 29)

is in operation. In order to understand the advantages of F-M more clearly, we will consider the differences between amplitude and frequency modulation transmission.

F-M Versus A-M

When no sound is being transmitted, as during a pause between announcements, the graphical representations of an F-M and an A-M signal are identical. This fixed frequency signal, shown in figure 1, is called the carrier. In the United States, commercial A-M stations operate on fixed frequency carriers in the range from 540 to 1600 kilocycles; commercial F-M stations in the range from 88 to 108 megacycles. Theoretically, however, F-M or A-M transmission would be possible on any frequency.

In order to transmit sounds, the carrier must be altered, or modulated, in some respect by them. The fundamental difference between A-M and F-M transmitters is that the former vary the amplitude of their carriers, while the latter vary the frequency of their carriers. As an illustration, let us assume that the sound to be transmitted is a single musical tone of 400 cycles per second, as shown in figure 2. Then the modulated carrier of an A-M transmitter would appear as in figure 3 and the modulated carrier of an F-M transmitter as in figure 4. A sound of high volume will increase the peak amplitude of the A-M signal; it will increase the peak magnitude of the frequency deviation of the F-M signal. A higher frequency sound will decrease the distance between the modulation peaks on the graph of the A-M signal; it will decrease the distance between the frequency maxima (and minima) on the graph of the F-M signal.

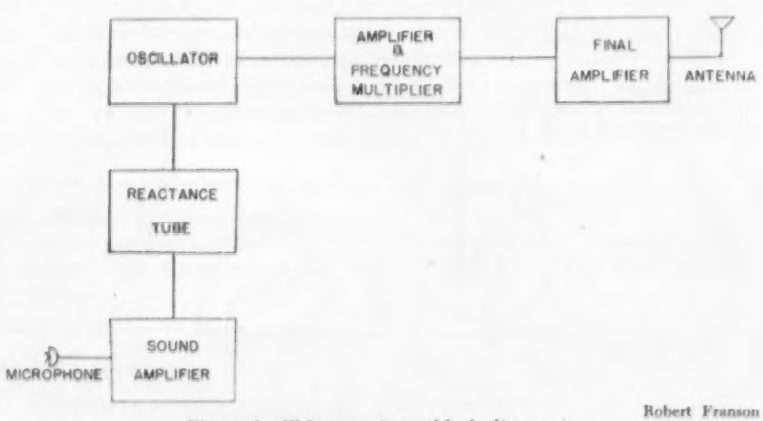
The most important characteristic of F-M communication is its freedom from unwanted noise. Originating principally in lightning discharges, noise impulses such as those in figure 5 superimpose themselves on the desired A-M or F-M signal. An A-M receiver is unable to differentiate the noise pulse from the modulated signal, for both appear as variations in the amplitude of the carrier. An F-M receiver, on the other hand, is designed to respond to frequency variations of the signal and is almost totally insensitive to variations in amplitude.

The maximum allowable bandwidth for A-M transmitters in the standard broadcast band is 10 kilocycles; that for F-M transmitters in the F-M band is 200 kilocycles. Though a direct comparison is not accurate, the maximum sound modulation frequency in each case is a function of the bandwidth, as in each case modulation creates sidebands on either side of the carrier. In practice the result is that on the A-M band sound modulation frequencies above 5000 cycles are usually lost, whereas on the F-M band sound modulation at 15,000 cycles is easily transmitted. Therefore F-M broadcasts can include the full range of frequencies audible to the human ear. The improvement in quality is principally due to the fact that wider bandwidths are available in the region around 100 megacycles. It is not a result of the form of modulation used.

F-M Is Cheaper

Simple block diagrams of typical A-M and F-M transmitters are shown in figures 6 and 7. Although it appears somewhat simpler, for a given power output, the A-M transmitter is usually more expensive to build and operate. The sound amplifier in an A-M transmitter must be capable of a large power output in order to fully modulate the final amplifier. The sound amplifier and reactance tube in the F-M transmitter operate at very low power levels. The final amplifier in the A-M transmitter cannot be operated at maximum power efficiency for, if it were, it would introduce considerable amplitude distortion. On the other hand, the final amplifier of the F-M transmitter may be operated at full efficiency. Since there is no variation in the amplitude of its output, there is no chance of amplitude distortion. An F-M transmitter's greater efficiency enables it to use less electric power than its A-M counterpart.

One disadvantage of F-M is that reception usually cannot be obtained over distances greater than about 50 miles. This is due to the fact that electro-magnetic radiation at high frequencies travels only in straight lines and does not reflect from atmospheric layers as does lower frequency radiation. Within a line-of-sight radius from the transmitter antenna, however, reception is clean and noise free.



Robert Franson

Figure 6—FM transmitter (block diagram).

PHYSICS & THAT FIRST YEAR

(Continued from Page 23)

nancial security. This fault is one which could be corrected, to some extent, by an experienced guidance counselor in high school before the student selects his course of study. Here also the parent should use judgment and not urge the offspring to choose to become an engineer, a physician, a lawyer, or a scientist just because they know of such people who have good incomes. Parents must realize that the individual himself must have an interest in his line, other than the financial income, before he can be a success and enjoy his work. Financial income is a poor criterion to apply alone in choosing a life work.

Frequently teachers hear college students say, when discouraged, "If I had known I had to have all this physics and mathematics to become an engineer, I would never have selected engineering." One cannot be a success in a field if he has no interest in its basic components.

An engineering student who was having trouble with freshman physics recently said to the writer in a discussion of his difficulties: "I had quite a time deciding whether I was to specialize in accounting or in engineering." A good guidance counselor could have helped this student for it was clear that he had little aptitude for science and he had apparently had in mind the financial returns rather than interest in the work he expected to do.

Getting Down to Work

Next on the list would be the habit of procrastination—postponing assigned work until a future date. The night before the "Prelim" is a popular date to set upon which back work can be made up. The sin of procrastination takes its toll in all lines of work, but it is particularly dangerous in the study of physics. If the study schedule recommended by one's class advisor is followed, the work proceeds smoothly, but once an assignment is neglected confusion on future assignments results.

High on the list would be the habit of "giving up" too soon in the solution of problems and going to upperclassmen or tutors for help. Too much cannot be said in favor of "sweating out" the work for one's self. We learn by doing for ourselves, and the habit of "stick-to-itiveness" is a worthwhile habit and will result in confidence in one's ability to carry on independent work.

A worthwhile characteristic of a student is that of establishing a frank, friendly, and clear relationship with his instructor. An antagonistic attitude is unfair to both student and instructor. Few instructors are unsympathetic toward their students and frank statements by the student concerning the parts of the work that cause him difficulty are of help to both student and instructor. One should not attempt to hide from his instructor his ignorance relative to any portion of the work, and physics of all subjects is the last one in which to attempt to carry on any "bluff."

In the solution of problems the student should analyze the problem, determine the basic physical laws involved and then apply the laws. Expressing the basic laws for problems results in mathematical equations and one of the most valuable tools to use in the study of physics and engineering is mathematics. The mathematics prerequisites of physics courses are usually specified, and the student should be sure he has satisfied these before starting the study of physics.

Each first year college physics class has present in it a number of members who were so impressed with their high school physics course that they feel they will not be called upon to pay close attention to the work of their college course. There are many excellent high school physics courses and loyalty to one's high school is to be extolled, but the student should first try his hand in the work assigned before he finds himself buried in confusion.

Consistent, conscientious, and continuous work will satisfy the conditions for satisfactory completion of courses of physics, and an interest in the subject is one of the prime prerequisites.

In conclusion, if the writer has succeeded in pointing out some of the pit-falls which students of engineering fall into in their study of physics, he will have achieved his purpose.

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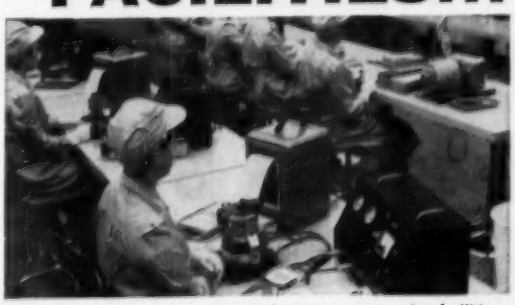

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FACULTY PROFILE:

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PROF. N. A. CHRISTENSEN

Director of Cornell's Civil Engineering School is only one of many accomplishments Professor N. A. Christensen has achieved during his busy lifetime. In his middle fifties and graying at the temples Professor Christensen is in his tenth year as Director of the School. He can properly be termed a self-made man, for his accomplishments in the fields of research, administration and education have been a direct result of his intense, unceasing efforts.

A stocky six footer, Professor Christensen appears as determined and serious about his work as his record indicates. Rarely cracking a smile, he speaks in a fast and positive manner, but he hesitates often before speaking in order to be as precise as possible.

Born fifty-four years ago in Prova, Utah, the director began his professional career by entering Brigham Young University in 1921. While there he majored in science and mathematics. As an undergraduate he had his first experience in teaching by helping professors as a lab assistant.

"In those days it wasn't easy to get a job," recalled Prof. Christensen.

He hesitated a few moments before he continued, "You could say it was partly this and partly the fact that I had to depend on experience for judgment that turned me toward civil engineering. My father died when I was thirteen thus I lacked a lot of parental guidance. I had to experiment with different things to see if I liked them."

He entered the engineering college of the University of Wisconsin that same summer of 1925 in pursuit of a civil engineering degree. Leaning back in his swivel chair with his hands clasped together on the back of his head, he recalled some of his early days in engineering school. "At first I had trouble with engineering problems, because I always worked them out the long way by deriving the proper formulas from calculus and physics." He hesitated again and smiled saying, "I couldn't do them as fast as the others but I gained some fundamental principles which were very important. In engineering problems you've got to use quick reference formulas, but you should know why the formulas are true. My first four years in arts and sciences were very important preparation for engineering school in such respects, although I wouldn't ask others to go through the same mill I did—that would be going too far."

Apparently Prof. Christensen did catch up to the others in engineering school, for in June 1928 he graduated with honors, receiving his BSinCE degree. For the rest of that summer he was a highway engineer back in Utah, but when fall came he joined the faculty of Ricks Junior College in Idaho as professor of science. This was not his first formal experience as a teacher, for he had taught mechanical arts in a Utah high school between terms in engineering school.

In 1932 he resumed his education at California Institute of Technology. Two years later he received his MS in civil engineering. For the next four years he taught, studied and did extensive research in hydraulics at California Institute of Technology leading to his PhD. Prof. Christensen then accepted the position of Dean of Engineering at Colorado State College. During the war he left Colorado State to serve on the rocket research team at Aberdeen Proving Grounds. He returned to Colorado State after the war until he was named Director of our Civil Engineering School in 1948.

"I've been very happy since I came here," said Prof. Christensen relaxing as he leaned back on the arm of his chair.

Because of the recent contro-

(Continued on Page 68)

Left to right: Lou Bernardi, Notre Dame, '54; Norman Lorenson, Mich. St., '55; Ernest Schurmann, M.I.T., '53; Dick Swenson, Purdue, '50.

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This ad appeared in the February, '08 *Engineer.*

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—Editorial, *December 1906*

(Continued on Page 68)

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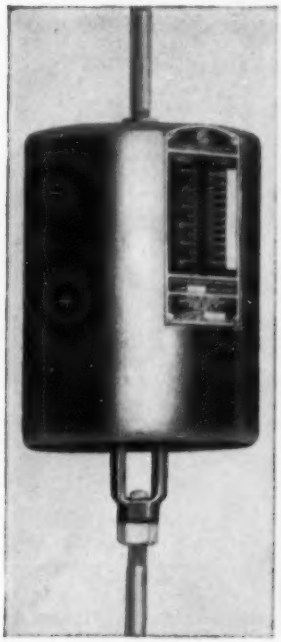

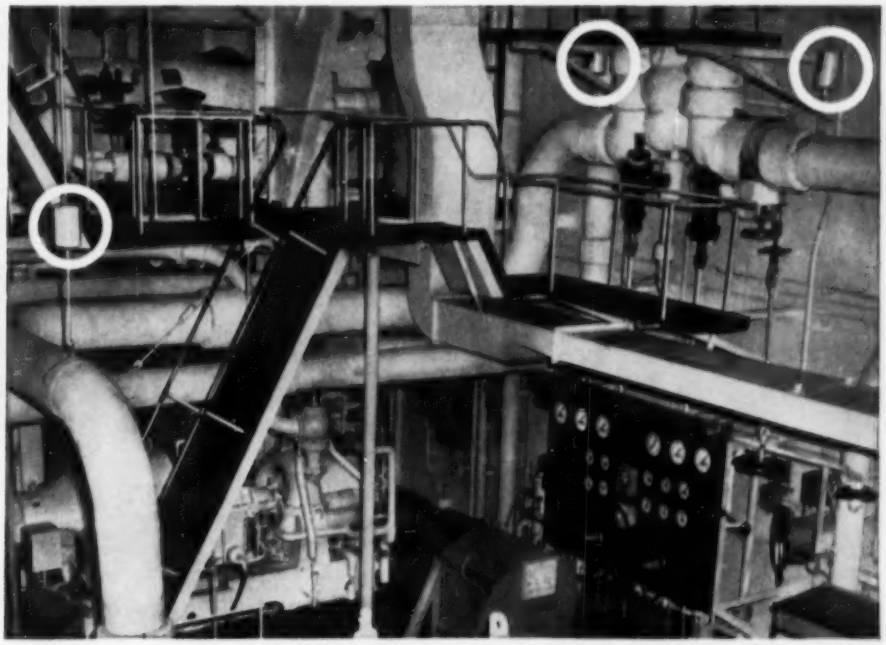

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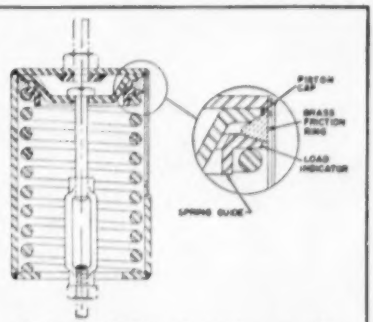

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ATOMS FOR THE FUTURE

(Continued from Page 27)

Navy can launch vehicles with atomic warheads, means that the United States has mobile bases from which it can reach any part of the world without yielding to the sovereignty of any other nation. That fortunate fact provides a checkmate to any form of political pressure to undo the peripheral land defenses built for protection against any enemy air force.

Russia's scientific achievements have indicated that the United States is running a close race. Research efforts must be extended and intensified if adequate defense is to be assured.

However, defense is not the only aspect of the problem to be considered. The entire civil economy will, in the long run, depend on this added source of energy together with its isotopes and, in addition, its by-product radiation sources for the chemical and food industries—all so that the economy can in turn progress and furnish the support necessary to this country's continued existence as a leading world power. Only through these means can the United States' position as a free nation be permanently assured.

FACULTY PROFILE

(Continued from Page 62)

versy concerning secondary school preparation of students for college it seemed natural that Prof. Christensen should hold some interesting views on the subject. When asked he hesitated again and then replied, "Engineering professors aren't ever satisfied with the preperation of students. Because I taught in high school I think I realize their problems. There are numerous demands made on secondary school educators that we don't encounter in college. It's very difficult to educate the great masses of people today and we shouldn't jump on those teachers just because of recent events. The real problem is our whole economic environment."

For those of our readers who are still undecided about engineering as a career Prof. Christensen gave this stern advice. "Don't choose engineering just because it's the thing to do these days or because it appears to be a well-paid, dramatic profession. Only those students born with certain abilities can bring them out. Others not so gifted with certain abilities should stay away from the fields that demand these abilities no matter how attractive they look. Not everyone should turn to engineering just because of the money, for its hazardous to judge money as a reason to enter any profession."

Before the interview closed Prof. Christensen couldn't help but mention, with intense pride reflecting in his face, the new home of the Civil Engineering School being built on the western end of the engineering quad. While he stated that he certainly had a sentimental attachment for the aging Lincoln Hall, the new building, which he thinks will be completed in the spring of 1959, will certainly expand and improve the C.E. School's ability to educate high quality engineers. —R. Lamm, ChemE '61

FIFTY YEARS AGO

(Continued from Page 64)

"If a course is to give a real professional engineering education, starting with the ordinary high school graduate, five years is not too long, and in this, the first year may well be taken up entirely with courses in liberal arts, with possibly the addition of a course on engineering operations in general. . . . In his latest discussion Dr. Steinmetz calls attention to the inappropriateness of spending large sums for expensive buildings in which poorly paid teachers are to instruct, and says that 'After all, engineering buildings and college laboratories are of secondary importance compared with the qualifications of the teacher and his assistants,' also that 'The glaring fault of the college curriculum is that quantity and not quality seems to be the object sought.'"

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Wayne had joined the Crusader dayfighter project in Preliminary Design, on alighting and arresting gear. He'd transposed his initial drawings into detail design and, later, he'd watched his gear pass jig and aircraft drop tests. At the Navy Test Center, the Crusader's gear absorbed maximum sink speeds and arresting tension, and Burch once more was there.

★

Now, Navy pilots on the *Bon Homme Richard* were taking the Crusader to sea, and Burch was going along. This time his assignment was simply to watch, and this time the Crusader was to be just part of the picture. Vought wanted him to experience carrier life and to see how his new weapon fitted in. For Wayne, whose sea log began and ended with one day's fishing from a 20-foot launch, it promised to be an eye-opening voyage.

For six days the designer shared quarters with Navy fighter pilots and had coffee with maintenance men. He studied aircraft spotting and catapulting, and he learned the sign language of the LSO (Landing Signal Officer). He marveled at the fingersnap timing of the Navy's deck handlers and at the *Bon Homme Richard's* mid-voyage refueling of two bobbing destroyers.

★

Wayne calls it "one of the most enjoyable weeks of my life" . . . and, as other sea-going Vought engineers have discovered, "one of the most profitable, too.

"Now I know the pilot's job, what maintenance wants . . . how really big the operation is.

"It's something you don't get if you stick too close to design.

"I guess you'd call it *perspective*."

At Chance Vought the designer stays in touch with his product . . . Contact begins in development, extends through test and includes, when possible, a study by the designer of the tactical environment in which his weapon will serve.

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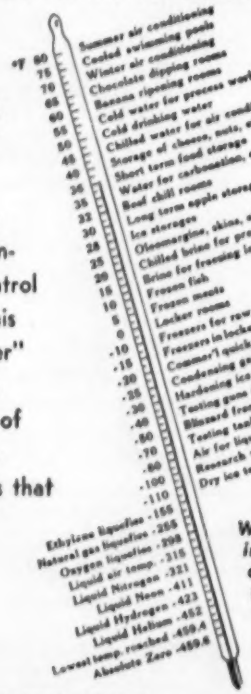

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Pump-turbine design is now the work . . . hydraulics, the field . . . of John Jandovitz, BSME graduate of College of City of New York, '52.

Water conditioning chemical, service, and equipment specialist in Houston is new assignment of Arthur Brunn, BS Chem. E., University of Tennessee, '56.

Field sales engineering of America's widest range of industrial products is choice of Roy Goodwill, BSME, Michigan State College, '54.

Recent Training Course Graduates

select wide choice of careers at Allis-Chalmers

Starting up a cement plant in Mexico after coordinating all work on it is latest job of John Gibson, BS Met. E., University of California, '54.

Nucleonics is chosen field of R. A. Hartfield, BME, Rensselaer Polytechnic Institute, '53. Currently he is working on design and development of new nuclear power plant.

THERE'S variety at Allis-Chalmers. Whether you're thinking in terms of types of industries, kinds of equipment, types of jobs, or fields of work, the diversification of Allis-Chalmers provides unsurpassed variety. For example:

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Research	Agriculture	Tractors	Metallurgy
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Manufacturing	Chemical	Screens	Mechanical Design
Application	Construction	Earth Movers	High Voltage Phenomenon
Sales	Electric Power	Transformers	Stress Analysis
	Mining	Crushers	Nucleonics
	Nuclear Power	Reactors	Electronics
	Paper	Control	Hydraulics
	Petroleum	Pumps	Acoustics
		Motors	Thermodynamics
		Steam Turbines	

An outstanding training program, started in 1904, is designed to help you find the activity within these groupings for which you are best suited. Up to two years of theoretical and practical training are offered. Direct employment at Allis-Chalmers is available for those with sufficient background.

Learn more about Allis-Chalmers and its training program. Ask the A-C district office manager in your area or write Allis-Chalmers, Graduate Training Section, Milwaukee 1, Wisconsin.

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San Fernando, Cal. . . 15151 Bledsoe St.
Palo Alto, Cal. . . . 937 Commercial St.

FTL
A DIVISION OF IT&T
Federal Telecommunication Laboratories
A Division of International Telephone and Telegraph Corporation

FTL's East Coast Laboratory, Nutley, N. J. —only 28 minutes via bus from New York

IAESTE

(Continued from Page 46)

has accepted his employment offer, he may take part in a chartered plane flight to a centrally located European city (usually Amsterdam) arranged by the American IAESTE committee. This flight gives the student about thirteen weeks in Europe. He is required to work for only eight weeks, however, thus giving him time for touring and sight-seeing. During his employment he is paid a wage sufficient for room and board and incidentals. Living quarters are often arranged by the employing company. The types of accomodations available vary—they include living alone, or living in special company living quarters, or rooming with a family.

In most cases, the student need not know the language of the country to which he is applying. Only Germany and Switzerland require that students working in these countries have a working knowledge of German. However, those students who could not speak the national language generally found this to be a limitation at first. By the time they left, however, the majority of them had gained enough knowledge of the language to be able to converse freely in it.

The opportunities available abroad under the program are many and varied. They include all phases of engineering and science. The student abroad finds himself very often in the position of a guest of honor. He is given tours of the entire industrial operation and of the company's branch offices throughout the country. He is sometimes permitted the freedom to spend as much time as he wishes observing any phase of the industry which interests him. However, warns Mr. Wischeidt, the program is primarily a work program, so "be prepared to work—get to work and learn."

• • •

Further information regarding IAESTE may be obtained in the Student Personnel Office in Carpenter Hall, or by writing directly to Mr. Josef Wischeidt, Secretary, IAESTE, Institute of International Education, 1 East 67 Street, New York, New York.

John Lenard, Arts '58

TECHNIBRIEFS

(Continued from Page 53)

radiation in hospitals, in fundamental physical studies of radiation, in the applications of radiation to industrial processes, and, of course, in the manufacture of radiation meters.

This ability of radiation to produce ionization is used in the determination of "exposure dose," which is a measure of the radiation reaching a given point (i.e., small region), based on the amount of ionization that the electrons originating at the point could produce in air. The unit of exposure dose is the *roentgen*. The exposure dose at a point is 1 roentgen when the electrons originating per 0.001293 grams of air (the mass contained in 1 cm^3 at standard temperature and pressure) can produce negative (or positive) ions of 1 esu total charge.

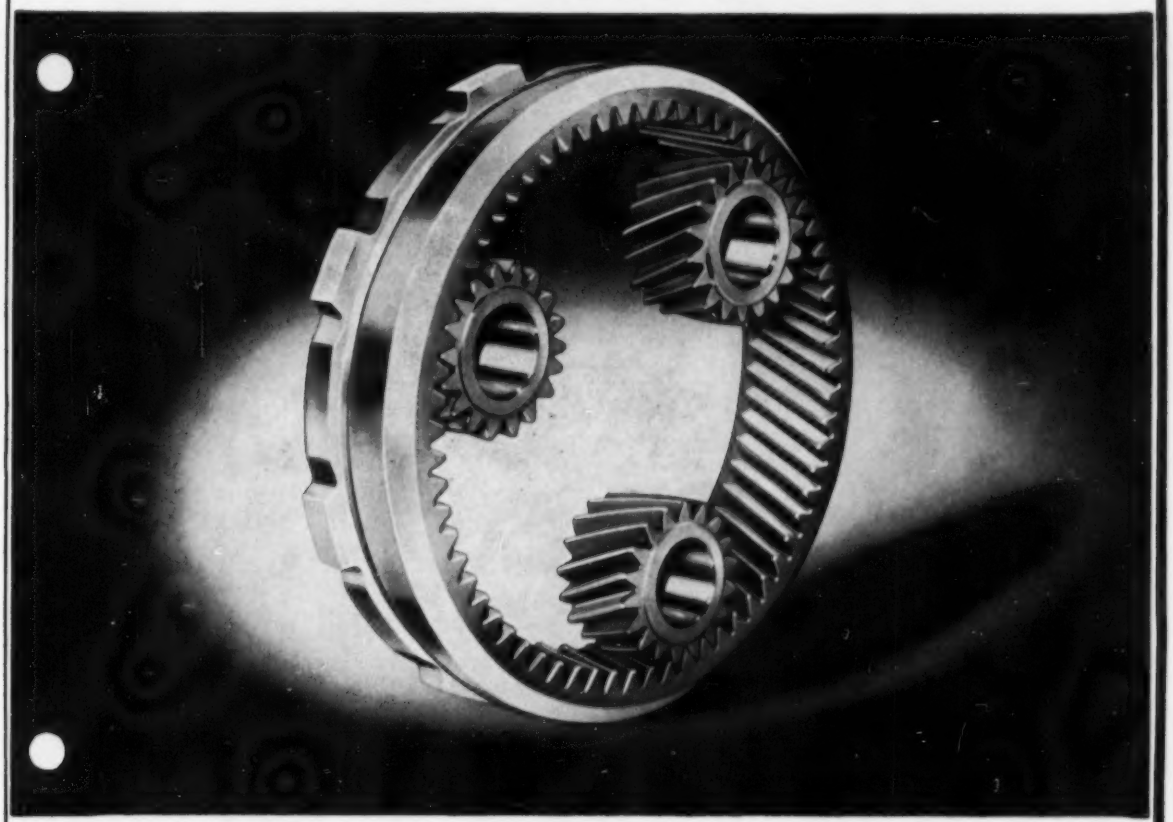
The instrument operates on the same basic principle as the free-air chamber. There is a small chamber of about one cubic centimeter in volume containing air, from which the ions produced by radiation are collected and measured. The wall of the air cavity is made of graphite and is just thick enough to keep out electrons ejected by high-energy cobalt rays from air particles outside the instrument or from such things as the lead-collimating slits that channel the rays into a narrow beam. Projecting into the cavity is an aluminum center electrode, and the ions are collected by applying an electrical potential between this electrode and the graphite wall. A short length of coaxial cable and connector are provided for connecting the chamber to the electrometer used to measure the charge of the ions. Then, from the measurement of charge the exposure dose in roentgens can be calculated.

ALUMNI NEWS

(Continued from Page 43)

Amy Clark Spear, BEE '48, is an instructor in the electrical department of Mohawk Valley Technical Institute in Utica. In her spare time (after taking care of four daughters), she plans on how best to remodel the house bought last year. Her husband is **E. D. Spear '45, BEE '47.**

Tear out this page for **YOUR STEEL NOTEBOOK...**



Steel nest that hatched a smoother transmission

YOU'RE looking at a ring gear "nesting" three smaller gears. It's part of one of the smoothest shifting transmissions ever put in a car. But it was almost too expensive to build.

Getting this extra smoothness called for squeezing more gears into the same size transmission case. Nesting was necessary to save space. And the big ring gear had to be extra tough. The problem was to make it economically.

The manufacturer turned to Timken Company metallurgists—acknowledged experts in fine alloy steels. They showed how to save the cost of boring out each gear—by starting with Timken® seamless steel tubing. The hole's already there. And the Timken steel has all the toughness a transmission needs. It's another example of how Timken Company metallurgists solve tough steel problems.

WANT TO LEARN MORE ABOUT STEEL OR JOB OPPORTUNITIES?

For information about fine steel, send for "The Story of Timken Alloy Steel Quality". And for help in planning your future, write for "Better-ness and Your Career at the Timken Company". Just drop a card to The Timken Roller Bearing Company, Canton 6, O.

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START TODAY TO PLAN TOMORROW

By knowing about some of the projects underway at the Babcock & Wilcox Company, an engineer may see his personal avenues of growth and advancement. For today B&W stands poised at a new era of expansion and development.

Here's an indication of what's going on at B&W, with the consequent opportunities that are opening up for engineers. The Boiler Division is building the world's largest steam generator. The Tubular Products Division recently introduced extruded seamless titanium tubing, one result of its metallurgical research. The Refractories Division developed the first refractory concrete that will withstand temperatures up to 3200 F. The Atomic Energy Division is under contract by the AEC to design and build the propulsion unit of the world's first nuclear-powered cargo vessel.

These are but a few of the projects — not in the planning stage, but in the actual design and manufacturing phases — upon which B&W engineers are now engaged. The continuing, integrated growth of the company offers engineers an assured future of leadership.

How is the company doing right now? Let's look at one line from the Annual Stockholders' Report.

CONSOLIDATED STATEMENT OF INCOME
(Statistics Section)
(In thousands of dollars)

1954	1955	1956—UNFILLED ORDERS (backlog)
$129,464	$213,456	$427,288

B&W engineers discuss developments in the Universal Pressure Boiler.

Ask your placement officer for a copy of "Opportunities with Babcock & Wilcox" when you arrange your interview with B&W representatives on your campus. Or write, The Babcock & Wilcox Company, Student Training Department, 161 East 42nd Street, New York 17, N. Y.

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It was considered a bold stroke, in Nathaniel Jenkins' day, to fix one's mark or name to the product of his invention. In 1864, product quality control was largely a matter of good intent and determination on the part of the maker. Nathaniel Jenkins *had* that determination and, as evidence of it, put his Diamond mark and signature on every Jenkins Valve.

Over the years, many new and different types of valves have joined the Jenkins Valve family. And because the rigid, quality specifications set by the founder have never been compromised, the Jenkins Diamond trade-mark has steadily gained in value.

Indeed, to buyers and specifiers of valves everywhere, this mark has become a trusted symbol of efficient, economical valve performance. Jenkins Bros., 100 Park Avenue, New York 17.

STRESS *and* STRAIN...

The High School senior's father wanted Bill to go to Cornell and be an E.E., just as he had done many, many years before.

"But I want glamor, fun, excitement, money, women!" the poor fellow pleaded, "Don't hold me back."

"Alright," the father answered, "I won't hold you back. But take me with you!"

• • •

The M.E. was unburdening himself with a group of fellows at his house.

"Ever since I've been at Cornell, all I've thought about is girls! Every morning I think about girls! Every afternoon I think about girls! Every evening I think about girls! All I ever think about is tall, beautiful, blond girls!"

"Why don't you go to a psychiatrist?" asked a brother.

"I did," admitted the M.E., "but for three weeks all he ever did was copy down telephone numbers!"

• • •

Ecstacy is a feeling you feel when you feel you are going to feel a feeling you have never felt before.

• • •

These succinct German-English translations are the product of German rocket scientists working at Huntsville, Alabama.

Guided Missile—Das skientifiker geschutenwerkes firenkrakker.

Liquid Rocket—Das skwirten jucenkind firenschpitter.

Rocket Engine—Firenschpitter mit schmoken-und-schnorten.

Solid Rocket—Das schtick kindlikercigareten firenschpitter.

Control System—Das pullen-und-schoven werke.

Warhead—Das laudenboomer.

Nuclear Warhead—Das eargeschplitten laudenboomer.

Hydrogen Device—Das eargeschplitten laudenboomer mit ein grosse hollengraund und alles kaput.

Sectionalization—Machtenze mit der pullenoudt und schoventogedder mit ein grosse schpede.

Reliability—Machtenze sodat alles mekanische parten micht ben schtoppen und gepfleinapardten.

Air to Air—Fromische uppenschteres geschuten tonudder uppenschteres bullzei.

Air to Surface—Fromische uppenschteres geschuten daunondekker.

Surface to Surface—Fromische daunondeker geschuten tonudder daunondekker bullzei.

Surface to Air—Fromische daunondekker geschuten uppen-uppenschteres Bullzei.

Management—Das ulzerenbaldden grupe.

Windtunnel—Das huffenpuffen grupe.

Public Relations—Das braggen und schnoen grupe.

Computing—Das schlidenruler grupe.

Structural Test—Das pullenpardten grupe.

Security—Das schnoopen bunche.

• • •

The father put off telling his six-year-old son about the expected addition to the family, until things reached a stage where the boy would be sure to ask questions. The father broached the subject to the boy by saying, "Bobby, the stork is coming closer and closer to our house."

Bobbie promptly answered, "I hope he doesn't scare mommy. She's pregnant, you know."

• • •

A bachelor never Mrs. anything.

• • •

Then there was the one about the two strawberries. One said to the other, "Honey, if we hadn't been in that bed last night, we wouldn't be in this jam now."

• • •

The Professor entered the doctor's office complaining about a persistant headache.

"You will have to cut out smoking," said the doctor.

"I never touch tobacco," replied the Prof.

"You must stop drinking."

"I never indulge in alcohol."

"Then you better go to bed early and stop running around with the women."

"I got to bed at nine every night and I am a bachelor."

At this point, the doctor paused and thought for a moment. He then replied, "Try getting a halo a few sizes larger."

• • •

"The editor's hair grows grey,
His fingertips grow sore,
Yet some so-and-so is sure to say
'I've heard that joke before'."

• • •

A first grade teacher fresh from college was taking over a class for the first time. Upon entering the classroom she noticed a nasty word on the black board followed by the signature: "The Phantom." So she said, "Now children, let's fold our little hands, put them on our little desks, and put our heads down onto the desks. Then the person who wrote this word on the blackboard can come up and erase it."

So they all folded their hands, put them on the little desks and put their little heads down on the desks. All was quiet for a while, then there was a thump, thump, thump of little feet, a pause, and the thump, thump, thump of little feet scurrying back to a desk.

After everything was quiet again, the teacher said, "Now let's see if the bad word is thoroughly erased." So they looked up at the blackboard to see a new, nastier word, followed by: "The Phantom Strikes Again!"

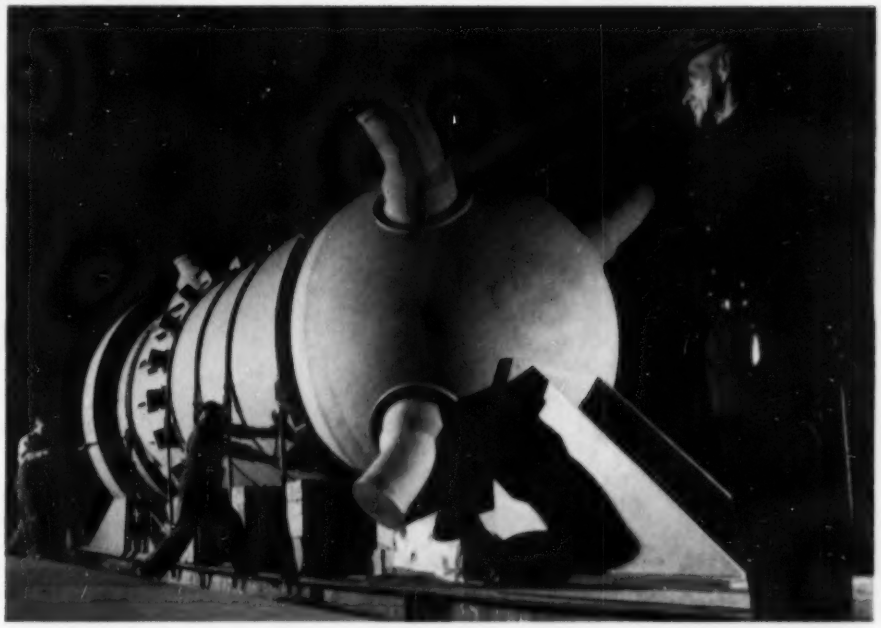
• • •

Nurse: "Doctor Jones, I believe that engineering student has passed his crisis."

Doctor: "How can you tell?"

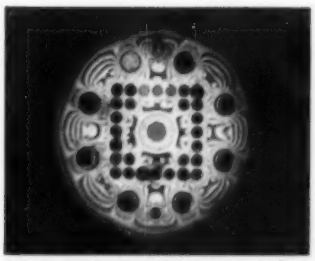
Nurse: "Well, when I left him he was trying to blow the foam off his medicine."

PHOTOGRAPHY AT WORK—No. 25 in a Kodak Series



Nuclear reactor vessel for Shippingport, Pa. power plant designed by Westinghouse Electric Co. under contract with the A.E.C. for operation by Duquesne Light Company.

Where atoms turn into horsepower



Photograph showing patterns of stress concentration. It was taken of a plastic model of a reactor vessel loaded to simulate the strains a real reactor vessel would undergo.

Radiographs of the reactor vessel welds were made with a 15,000,000-volt betatron. Every bit of the special steel, every weld had to be proved sound and flawless.

Combustion Engineering designed and built this "couldn't-be-done" reactor vessel for America's first full-scale nuclear power station. And photography shared the job of testing metals, revealing stresses and proving soundness.

COUNTLESS unusual—even unique—problems faced Combustion Engineering in creating this nuclear reactor vessel. Nine feet in diameter with walls 8½ in. thick, it is 235 tons of steel that had to be flawless, seamed with welds that had to be perfect. And the inner, ultrasmooth surface was machined to dimension with tolerances that vie with those in modern aircraft engines.

As in all its construction, Combustion Engineering made use of photography all along the way. Photography saved time in the drafting rooms. It revealed where stresses and strains would be concentrated. It checked the molecular structure of the steel, showed its chemical make-up. And with gamma rays it probed for flaws in the metal, imperfections in the welds.

Any business, large or small, can use photography in many ways to save time and money. It can go to work in every department—design, research, production, personnel, sales, and accounting.

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Interview with General Electric's Hubert W. Gouldthorpe Manager—Engineering Personnel

Your Salary

Although many surveys show that salary is not the prime factor contributing to job satisfaction, it is of great importance to students weighing career opportunities. Here, Mr. Gouldthorpe answers some questions frequently asked by college engineering students.

Q. Mr. Gouldthorpe, how do you determine the starting salaries you offer graduating engineers?

A. Well, we try to evaluate the man's potential worth to General Electric. This depends on his qualifications and our need for those qualifications.

Q. How do you evaluate this potential?

A. We do it on the basis of demonstrated scholarship and extra-curricular performance, work experience, and personal qualities as appraised by interviewers, faculty, and other references.

Of course, we're not the only company looking for highly qualified men. We're alert to competition and pay competitive salaries to get the promising engineers we need.

Q. When could I expect my first raise at General Electric?

A. Our primary training programs for engineers, the Engineering Program, Manufacturing Program, and Technical Marketing Program, generally grant raises after you've been with the Company about a year.

Q. Is it an automatic raise?

A. It's automatic only in the sense that your salary is reviewed at that time. Its amount, however, is not the same for everyone. This depends first and foremost on how well you have performed your assignments, but pay changes do reflect trends in over-all salary structure brought on by changes in the cost of living or other factors.

Q. How much is your benefit program worth, as an addition to salary?

A. A great deal. Company benefits can be a surprisingly large part of employee compensation. We figure our total benefit program can be worth as much as 1/6 of your salary, depending on the extent to which you participate in the many programs available at G.E.

Q. Participation in the programs, then, is voluntary?

A. Oh, yes. The medical and life insurance plan, pension plan, and savings and stock bonus plan are all operated on a mutual contribution basis, and you're not obligated to join any of them. But they are such good values that most of our people do participate. They're an excellent way to save and provide personal and family protection.

Q. After you've been with a company like G.E. for a few years, who decides when a raise is given and how much it will be? How high up does this decision have to go?

A. We review professional salaries at least once a year. Under our philosophy of delegating such responsibilities, the decision regarding your raise will be made by one man —the man you report to; subject to the approval of only one other man —his manager.

Q. At present, what salaries do engineers with ten years' experience make?

A. According to a 1956 Survey of the Engineers Joint Council*, engineers with 10 years in the electrical machinery manufacturing industry were earning a median salary of $8100, with salaries ranging up to and beyond $15,000. At General Electric more than two thirds of our 10-year, technical college graduates are earning above this industry median. This is because we provide opportunity for the competent man to develop rapidly toward the bigger job that fits his interests and makes full use of his capabilities. As a natural consequence, more men have reached the higher salaried positions faster, and they are there because of the high value of their contribution.

I hope this answers the question you asked, but I want to emphasize again that the salary *you* will be earning depends on the value of *your* contribution. The effect of such considerations as years of service, industry median salaries, etc., will be insignificant by comparison. It is most important for you to pick a job that will *let* you make the most of your capabilities.

Q. Do you have one salary plan for professional people in engineering and a different one for those in managerial work?

A. No, we don't make such a distinction between these two important kinds of work. We have an integrated salary structure which covers both kinds of jobs, all the way up to the President's. It assures pay in accordance with actual individual contribution, whichever avenue a man may choose to follow.

*** We have a limited number of copies of the Engineers Joint Council report entitled "Professional Income of Engineers—1956." If you would like a copy, write to Engineering Personnel, Bldg. 36, 5th Floor, General Electric Company, Schenectady 5, N. Y.** 959-7

LOOK FOR other interviews discussing: • Advancement in Large Companies • Qualities We Look For in Young Engineers • Personal Development.

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